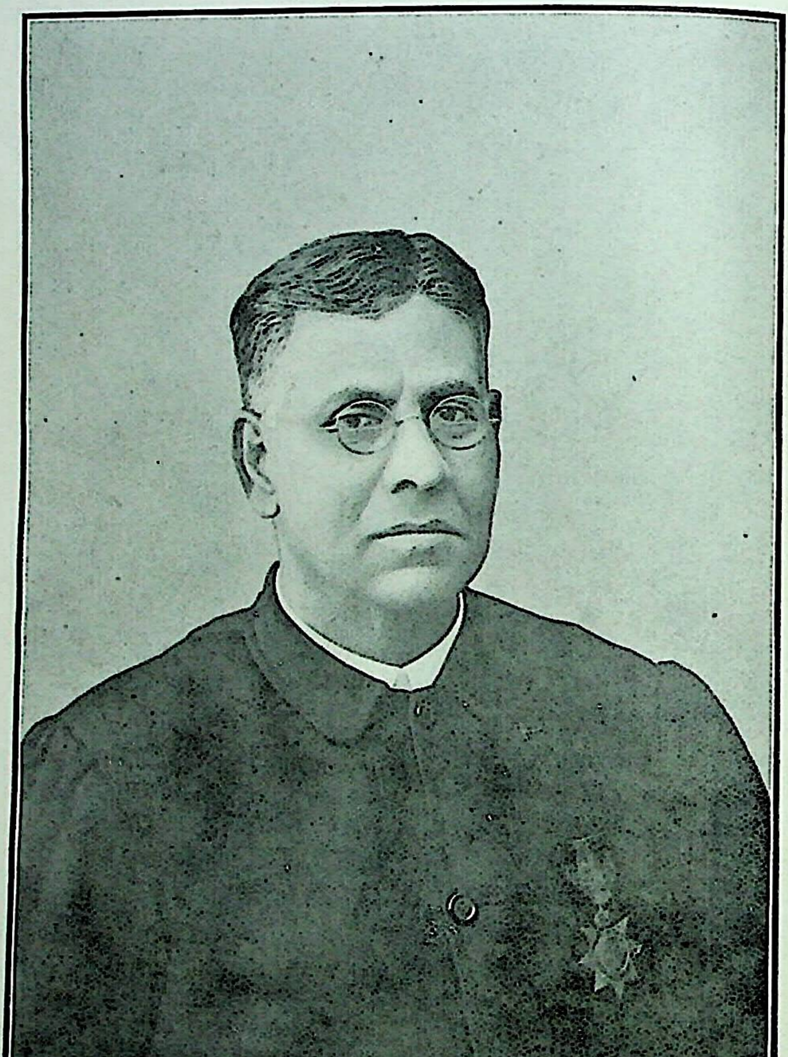
FOOD



THE LATE RAI CHUNILAL BOSE BAHADUR,
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Adharchandra Mookerjee Lectures for 1929

FOOD

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PREFACE.

This small book embodies the Adharchandra Mookerjee lectures on FOOD for 1929 delivered at the Calcutta University.

Only the salient features of the vast and important subject of Food and Dietetics could be dealt with within the ~~[illegible]~~ limited compass of these lectures.

The need of a small handbook in English on Food bearing on Indian life and Indian conditions has long been felt and it is hoped that the present volume will in a measure supply the want.

Calcutta,
The 1st August, 1930

Chunilal Bose

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FOOD

CHAPTER I

Introductory Remarks.

I have chosen *Food* as the subject for Adhar Chandra Mukherji lectures for more than one reason.

In the first place, the relation of Food to health is very intimate. But unfortunately, it seldom receives that amount of intelligent interest from the general public which it so rightly deserves. The science of Nutrition has now reached an advanced stage of development and the knowledge of its principles is now more complete and accurate than at any time before, and, for that very reason, it has become more complex and highly technical. The fundamental fact in *nutrition* is that complex chemical changes are effected in food-substances by means of physiological agencies in the animal body. For a proper understanding of questions of *food* and *dietetics*, a knowledge of Bio-Chemistry is essentially necessary, and this means a study of chemistry, physics and physiology.

Physiologists trace the changes that food undergoes in the stomach and intestines, ascertain the nature of the digestive agents which produce those

changes and determine the conditions under which those agents are produced in the human body. Chemists, on the other hand, determine the composition of food-stuffs and the changes which they undergo in the process of digestion, absorption and assimilation and study their special functions in the economy and nutrition of the system. The physical changes involved in the process belong to the domain of physics. Thus, food is taken into the body, digested, absorbed and then transformed into totally different substances in the animal organism. It goes to the building up of bones, muscles, and other tissues and the different organs of the body. To follow these changes and to understand the value of food, a knowledge of the chemical composition of food is necessary. To understand the means by which these changes occur—the processes of digestion, absorption and final utilization of the nutrient substances—a knowledge of both chemistry and physiology is required.

Secondly, within the last quarter of a century, much advance has been made in our knowledge of food and the science of nutrition by the discovery of certain alimentary principles present in most of the food-substances in their natural condition.

These are called *Vitamins*, which play a very important part in the growth and nutrition of the body and the prevention of certain diseases. I propose to devote one chapter to the consideration of this subject alone, the knowledge of which is now practically confined among medical men only.

A third reason for selecting *Food* as my particular subject is that our present Indian diet is de-

fective and ill-balanced and is directly responsible for the progressive deterioration of the physical health of the people, particularly of Bengal, and indirectly affecting their moral and economic well-being. It shall be my endeavour in the course of these lectures to deal generally with the problem of *Food* and *Dietetics* and to point out the main defects in the diet of the people and to suggest measures for their correction.

Food should be considered not only as a great necessity but also as one of the great enjoyments of life. It has been a factor of tremendous force in the evolution of the social life of man and has materially contributed to the progress of civilisation. The æsthetic and social aspects of food will ever exercise a healthy and elevating influence on the life of the community. The incidence of many diseases may be attributed, directly or indirectly, to over-feeding or under-feeding, and also to the bad quality of food-stuffs. Nature produces an immense variety of food-stuffs obtainable from different sources, animal, mineral and vegetable, which go to serve as materials for the building-up of the body, for supplying it with heat and energy and for renewal and repair of waste occurring during life. For this, we require certain nutritive principles to be present in our food-stuffs. An excess or deficiency in any one of these principles in our food causes great disturbance in the system, which, if prolonged, would cause the breaking down of health and give rise to many serious diseases. Infected and diseased food is often responsible for the incidence of such diseases as cholera, typhoid fever, tuberculosis, etc. Then,

again, certain deadly poisons, known as Ptomaines, sometimes develop in meat or fish, in which decomposition has set in, giving rise to serious troubles, sometimes attended with fatal consequences.

Again, some of the common food-stuffs are found to be largely adulterated with more or less deleterious substances. Such bad food causes dyspepsia and other troubles and leads to general deterioration of the health of the people and lowers their resisting power against infectious diseases.

The consideration of such an important subject, with which the health and the material prosperity of the people are intimately connected, cannot, therefore, fail to be interesting.

CHAPTER II

What is Food?

Food is that substance which, when taken into the system, goes to build up our body, contributes to its repair due to constant wear and tear, supplies the body with heat which is necessary for vital operations, and gives us strength and energy to accomplish all kinds of works. Rice, *dal*, flour, vegetables, fruits, sugar, milk, meat, fish, eggs, etc., constitute our daily diet. Most of them require the process of cooking before they can be utilised in the system as food, but there are certain articles such as milk, sugar, fruits, etc., which are fit to be taken as food in their natural condition, without being subjected to the process of cooking.

The object of *dietetics* is to determine what kinds, quantities and combinations of food-substances will exactly meet the requirements of the body, under varying conditions of life.

A two-fold line of enquiry should thus be followed :—

(1) To ascertain the needs of the system.
(2) To find some practical means of estimating the nutritional and energy-giving value of the various food-substances in order that these needs may be satisfied.

Now, food-requirements of the body vary according to age, sex, occupation, habits, weight of the body, climate, etc. The composition of food-

substances also differs in their chemical constitution, in their taste and texture, in their digestibility, and in the quantity of assimilable materials contained in them.

We have already stated that the food we take serves three distinct purposes, *viz.*,

(1) as fuel which generates heat and muscular energy;
(2) as building materials which go to form muscles, bones and other tissues; and
(3) for renewal and repair of wastage occuring during life.

With the help of oxygen taken in the act of breathing, a slow process of combustion takes place in the system in the cells of the body when digested food is taken to them by the blood. The carbon and hydrogen elements of the food-stuffs, as the result of such combustion, are converted into carbon dioxide and water respectively, the water being mostly drained off through the skin and kidneys, and the carbon dioxide being carried back by the blood to the lungs and thrown out in the act of respiration. The heat generated during such combustion partly goes to maintain the body-temperature at its normal standard (98·4 F°) and is partly transformed into mechanical energy of the body, which helps the internal organs such as the heart and the lungs, etc., to continue their movements, and enables us to perform all kinds of physical and mental work by the exercise of our muscles and the brain. The function of food has often been compared to the function of coal or

other kinds of fuel used in the working of a steam-engine with these differences, *viz.*, that,—

(1) whereas an engine has only one furnace or a limited number of furnaces, the body has several millions of furnaces in the shape of tiny cells which constitute its elementary structures; and

(2) that a steam-engine does not repair itself; the living organism does.

"Scattered throughout the soft tissues, and particularly numerous in such regions as the biceps, the calves and the thighs, are countless small muscle-cells. Each one of these cells is an active living entity: each one is capable of absorbing a minute quantity of the food-substances which are carried to every part of the system by the blood, and literally burning it up to produce heat and "Power" in the form of muscular energy."* Again, certain special kinds of food-particles are absorbed and *retained* by the living cells, and instead of being consumed, they are incorporated into the structure. This process is most active during the period of growth. The particles are retained for use as building materials. The old cells die, giving place to new cells, and in a growing organism, the formation of new cells is more rapid than the death of the old. When the period of growth is ended, only repair and replacement of cells take place.

Considered only as fuel or building materials, the whole range of food-stuffs may be grouped into

*"*The Science of Nutrition Simplified*," by D. D. Rosewarne, p. 16.

six distinct classes, known as the nutritive or proximate principles of Food. These are :—

1. *Proteins.*
2. *Fats.*
3. *Carbo-hydrates.*
4. *Mineral matters.*
5. *Water.*
6. *Vitamins.*

Proteins and mineral matters are mainly concerned in the growth, development and repair of the body. Fats and carbo-hydrates are principally used as fuel for production of heat and energy, and the vitamins help the whole process of metabolism and nutrition, foster growth and increase the resisting power of the body against infection. Proteins are capable of producing heat and energy by combustion like fats and carbo-hydrates, but in ordinary circumstances, they are utilised as building materials for growth and repair of the body. In the absence or *deficient supply* of carbo-hydrates and fats, proteins take their place and supply heat and energy, as in the case of people in certain parts of the world who practically live on meat and water only.

CHAPTER III

PROXIMATE OR NUTRITIVE PRINCIPLES OF FOOD AND THEIR FUNCTIONS.

We have, before this, briefly considered the need for food. We now propose to deal with the alimentary principles of the various food-stuffs, their respective functions, their composition and the part each plays in the economy of the body. But before we consider these food-principles, we must first find out what materials our bodies are made of, because the food we take goes to build up the body and to make up for the constant loss of these materials from the system.

The different kinds of matter we see all around us can be classed under two principal heads, *viz.*, the elements and the compounds. Gold, Silver, Copper, Iron, Sulphur, Carbon, Phosphorus, etc., each of these is an element or simple substance, because nothing simpler than itself can be obtained out of any one of them. Up to this time, there have been discovered 82 elements only.

A compound substance, on the other hand, is made up of two or more simple substances and their number is unlimited. Sand, wood, lime, stones, animals, plants, etc., which constantly come under our observation, are examples of compound substances. Water, for example, is formed by the chemical union of two elements, Oxygen and Hydrogen; it is therefore, a compound substance. Bones (about 16 per cent.), skin (about 8 per cent.),

muscles (about 42 per cent.), blood (about 5 per cent.), blood-vessels, brain (about 2 per cent.), nerves, ligaments, fat (about 18 per cent.), viscera (about 8 per cent.) and such other tissues as enter into the composition of our body are, each and all, examples of compound substances. According to Volkmann and Bischoff, human body contains about 64 per cent. of water, 16 per cent. of proteins, 14 per cent. of fat, 5 per cent. of mineral matter and 1 per cent. of carbo-hydrates in the form of glycogen and glucose.

Of the 82 elements, about sixteen are to be found in the human body, and among them, Carbon, Oxygen, Nitrogen, Hydrogen and Sulphur are the most important ones. On an average, there is about 1/6 part of Carbon, 1/8 part of Hydrogen and 1/22 of Nitrogen per weight in our body. Beside these five elements, there are others, such as Phosphorus, Chlorine, Iodine, Fluorine, Sodium, Potassium, Calcium, Iron, Manganese, etc., present in greater or less proportions in our body. With the exception of Oxygen, all the other elements exist in the body in the form of compounds. Oxygen alone is present both as an element and as a compound.

The elements composing the human body must, all of them, be present in our food. But it will not do to take them as food in their simple elementary form. For instance, Nitrogen in the elementary form is one of the principal constituents of the air and it is present there in abundant quantity. Again, charcoal or coal forms one of the elementary forms of carbon and may easily be obtained in Nature in any quantity in uncombined state. But to get the

required supply of Nitrogen and Carbon for the body, it would not do if we take air or eat coal or charcoal. Plants are capable of drawing their nourishment from the air or the soil on which they stand from simple inorganic substances contained in them. But animals can never do so. They must obtain nourishment from complex substances formed in the bodies of plants and animals. Flesh, eggs, milk, starch, fat, oils, sugar and other similar food-stuffs are highly elaborated products of either animal or vegetable origin. By taking them as food, we are able to obtain the various elements required for the building up of our body.

It must be noted here that the primary source of food of all animals is the vegetable world. The plants obtain their food in an inorganic (or elementary) form from the air and the soil, elaborate these in their tissues and store the finished products in the form of different kinds of organic compounds, such as vegetable albumen, sugar, oil, starch, etc., in their roots, stems, leaves, fruits and seeds. These are eaten by the herbivorous animals such as cow, sheep, goat, etc., and are transformed into muscles, fat, blood, bones and other tissues in their body. Carnivorous animals live on the flesh of the herbivorous and, therefore, indirectly on products originally elaborated in the bodies of plants. We thus see that the foods stored in plants directly support the lives of the herbivorous, and indirectly, of all carnivorous animals.

Kind Nature has stored a complete and pure food for the helpless infant in the breasts of its mother. Milk is the only complete food found in

nature, because it contains in due proportions all the ingredients that are necessary for the child for the growth of the body, for the repair of waste and for supply of heat and energy.* Some people can maintain good health by taking milk only, but it is not convenient for most grown-up people to live on milk alone. We must, therefore, use such other food-stuffs in which all the component parts of milk are present. Let us now see what we have in milk which help to support life and contribute to the growth of the body.

If we add some acid substance, such as lime-juice, to milk, we notice that it gets curdled, and a solid mass which is called casein (*chhana*) is thrown down. Besides casein, milk contains butter, sugar, salts, vitamins and water. When milk is churned under suitable conditions, butter is obtained. When both casein and butter are separated from milk, the watery portion left behind contains the milk-sugar and various kinds of salts in solution. What remains after the separation of sugar and the salt is water only. The vitamins are chiefly contained in the fat of the milk. We thus see that the different ingredients of milk which nourish the body are the casein (protein), the butter (fat), the milk-sugar (carbo-hydrate), the salts, the vitamins and water. They possess quite different properties and they differ from one another in their functions as food.

* Egg is considered to be another complete natural food, as chicks do not require any substance other than that contained in the egg for their development. But as carbo-hydrates are practically absent from eggs, they lack in completeness as food when compared with milk.

Water being an inorganic substance, it may conveniently be placed under the head of salts. We can classify the food-principles of milk under the following heads :—

(1) Proteins—(representing the casein of milk).
(2) Fats—(representing the butter of milk).
(3) Carbo-hydrates—(representing the sugar of milk).
(4) Salts—(representing the mineral matters of milk).
(5) Water—(representing the water of milk).
(6) Vitamins.

Now, whatever food we take, it should contain all the above six alimentary principles, as otherwise the nutrition of the body will suffer. As casein is the protein-principle in milk, so we find *myosin* in flesh, *albumin* in eggs, *legumin* in *Dals*, *gluten* in wheat flour and *fibrin* in oatmeal. Proteins repair the body-waste and help the growth of muscles and other tissues; hence this kind of food is also called the flesh-former. As Nitrogen is one of the principal ingredients of protein-foods, they are also known by the name of Nitrogenous or albuminous food. Meat, fish and eggs are principally protein-foods but they also contain fats and salts but practically no carbo-hydrates. Rice, on the other hand, is very rich in carbo-hydrates (starch) but poor in proteins, fats and salts. Sugar is a purely carbo-hydrate food and contains neither proteins, fats nor salts. Butter and oils are pure fats and contain no other food-principles except vitamins. In *dal*, flour, oatmeal, etc., both proteins and carbo-hydrates are present in good proportions

but they are generally deficient in fat. Rice is rich in carbo-hydrates but poor in protein and fat. *Dal* is even considered superior to meat in respect of its protein-contents but the protein of *dal* is biologically inferior to animal proteins in regard to its digestibility and assimilability; it contains very little fat and we have to add *ghee* or oil at the time of cooking it.

It will thus be seen that in milk only, all the different alimentary principles are present in due proportions, and that, therefore, there is no other food needed for small children. But it is not convenient for grown-up people to live on milk only, because a large quantity of milk would then have to be taken and this would entail the ingestion of water and some of the other food-principles considerably in excess of what is required for the maintenance of good health. Besides, a pure milk diet becomes too monotonous and the appetite loses its sharpness which is a necessary condition of good digestion and health. Of course, the alimentary principles contained in milk are, each and all, indispensably necessary for the repair of waste, for the growth of the body and for supply of heat and energy, but we can obtain these in required quantity from food-stuffs other than milk, such as rice, *dal*, meat, fish, flour, oils, sugar, fruits, vegetables, etc. We shall now briefly consider the respective functions of each of these different alimentary principles.

Proteins.—These are found in good quantity in fish, meat, eggs, milk, cheese, *chhana*, nuts and the various kinds of pulses (*dal*). Other food-stuffs such as rice, flour, etc., also contain protein in much

smaller proportions. The principal function of this kind of food-principle is to help growth, to repair the waste of muscles and other tissues and to build up the body. Our body is made up of countless number of cells too minute to be seen by the naked eye. A kind of jelly-like substance, called *protoplasm,* constitutes the formative material of these cells. Proteins contribute to the replenishment of protoplasm; hence they form the most important constituent of our food for the nourishment and growth of the muscles and other tissues of the body. They also help in the forming of the various secretions of the body and to some extent, contribute to the formation of fat. They possess dynamic action and stimulate the metabolic activity in the body. They also contribute to the production of heat and energy by combustion, but usually in the absence of carbo-hydrates and fat. All animal-proteins are biologically superior to the vegetable ones, and experience shows that it is greatly to our advantage if part of the protein (at least about one-third of our daily requirement) is derived from animal-sources such as meat, fish, eggs or milk which would considerably improve the nutritive value of our dietary. Proteins of proper quality and in adequate quantity must be present in our daily diet, as otherwise, " stunted growth, poor physique, poorly developed muscles, lack of vigour, low powers of endurance, incapacity for hard work, both physical and mental, rapid advance of old age, short life and reduction of the power of resisting infectious diseases "* will follow.

* McCarrison on " Food."

Fats.—These include butter, *ghee*, lard and the various other kinds of animal fats and vegetable oils used as food. They do not contain Nitrogen but consist of Carbon, Hydrogen and Oxygen only, but less Oxygen than is found in carbo-hydrates. The chief function of this kind of food is to generate the body-heat from which we also obtain strength and energy for all kinds of work. It is from fats and carbo-hydrates that we obtain the whole supply of heat and energy. They are, therefore, called the fuel-parts of our food. Some people have got the mistaken notion that meat is the principal source of our strength and energy. It is not so. Proteins of meat, as a rule, are not usually utilised in the system for production of heat and energy, but they go to make up for the waste of muscles and other tissues and contribute to their growth. Heat and energy for any kind of work are yielded by fats and carbo-hydrates. Fats also help in the formation of fat in the body and are the principal sources of supply of the vitamins A and D. It also prevents loss of heat by the body.

Carbo-hydrates.—These comprise starches and sugars and are present in rice, potato, flour, sugar, arrow-root, barley and a number of other common food-stuffs. As in fats, there is also total absence of Nitrogen in carbo-hydrates; like fats, they contain Carbon, Hydrogen and Oxygen only, but are richer in oxygen than fats. The ratio of Hydrogen and Oxygen in carbo-hydrates is the same as we find in water. They are principally concerned in the production of body-heat and energy, but weight for weight, they produce less heat than fat. They also

help the formation of fat in the body, and people taking too much of this kind of food generally grow stout as is generally the case with well-to-do Indians. The carbo-hydrates help the proper utilisation of proteins and fats, and the latter (fats) are said to burn with the help of carbo-hydrates in the food. The Indian diet generally is defective in its containing too much of carbohydrates.

Water.—There is about 70 per cent. of water in our body. It is constantly being lost from the system in drainage with urine, perspiration and evacuation from the bowels. We replace the loss by taking liquid food, such as milk and solid food such as meat, fish, rice, fruits, vegetables, etc., all of which contain more or less water, and also by drinking water and other liquids. There is much water in our blood which keeps it in fluid condition and enables it to flow easily to all parts of the body, carrying the digested food which is taken up by the tissues for their growth and for repair of waste. Water softens and dilutes the food to thinner consistence, facilitating its digestion and rendering it easy for the blood to absorb it. Besides, it helps the elimination of the refuse of the food and other impurities which are constantly being formed in the body as the result of metabolism.

Salts.—Oxygen is placed under the head of salts by many people. Of all the elements entering into the composition of the human body, Oxygen is the only one which we take both in its elementary and compound forms. It is present in free condition in the air which we inhale, and although it does not directly act as a food, it helps the slow combus-

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tion and oxidation of the digested food and in this way, it generates body-heat and energy. We cannot live without Oxygen. Besides that contained in the air, we also get Oxygen from all kinds of food in which it exists in combination with other elements.

Common Salt (sodium chloride) which is daily taken by us as a food-accessory, is one of the most important salts required for the nourishment of the body. We do not take it directly with some kinds of food, such as milk and fruits, etc., because it is present there in sufficient quantity, and no extra quantity is required. But certain food-stuffs contain very small proportion of common salt such as rice and vegetables, and we mix salt in more or less quantity with these to supply the deficiency and to make the food palatable. Sodium chloride is present in the blood, in the muscles and in the other tissues of the body. When taken with food, it increases the flow of saliva, helps the liver to put out a liberal supply of bile and it is principally concerned in the manufacture of the acid-constituent of the gastric juice. Besides common salt, our food-stuffs contain a good many other salts such as those of lime, iron, phosphorus, potash, etc. Lime and phosphorus contribute to the formation of the bones and some other tissues of the body. The red blood-cells contain an appreciable quantity of iron which helps them to absorb Oxygen from the inhaled air and to maintain the slow combustion of food in the body which is the source of our body-heat and energy. For proper maintenance of health, salts are essentially necessary. They are present in abundant quantity in vegetables and fruits and they help to keep

the blood in its normal condition. If fresh fruits and vegetables are absent from our diet for sometime, the blood gets vitiated and a very obstinate disease called *scurvy* sets in, which can be cured by ingestion of fresh fruits and vegetables, and by administration of lime-juice.

Vitamins.—I have already said that within the last 25 years, a great advance has been made in our knowledge of the science of nutrition by the discovery of certain active principles which are present in most food-stuffs in their natural state and without which, even when all other nutritive principles are present in our dietary, growth is retarded and life and health cannot be maintained. These active principles are called *vitamins*, some of which are formed in the plants by the action of sunlight. The animals derive them either by eating plants or by living on plant-eating animals. They are present in the green leaves of growing plants and in their seeds and fruits.

Five different kinds of vitamins have up to date been discovered. They are classed as vitamins "A," "B," "C," "D" and "E," and they differ in their properties and functions. The vitamin "B," again contains two distinct vitamins known as B^1 and B^2. They all contribute more or less to the growth of the organism and their absence in our daily diet gives rise to certain diseases known as *deficiency* diseases, such as rickets, beriberi, scurvy, etc. I shall deal with this subject in detail in a separate chapter.

We thus see that even if we do not take milk, we can easily obtain all the six food-principles from

food-stuffs other than milk. For example, we can get the flesh-forming principle (protein) represented by the casein of milk from such food-stuffs as fish, meat, eggs, *dals*, nuts, etc.; the fats (represented by the butter of milk) from *ghee*, butter, lard, vegetable oils, etc., and the carbo-hydrates (represented by the sugar of milk) from rice, bread, potato, sugar, barley and other starchy and saccharine substances. The salts naturally present in these foods, together with the quantity of common salt we add to them in the course of their preparation, the water we drink and the vitamins contained in most of the food-stuffs, go to supply the place of salts, water and vitamins present in the milk. The absence of milk from the diet of an adult person is, therefore, not at all harmful, although the addition of a little milk would go generally to improve our daily diet.

I have already stated that, except in milk, the materials required for the growth and nourishment of our body do not exist in due proportions in other food-stuffs, and that milk is not always a convenient article of food for people other than children. It is, therefore, necessary to make a careful selection of our food-stuffs in order that we might obtain the required quantity of the different nutritive principles of food for the growth of the body and the maintenance of health and activity. Such food-stuffs are either of animal or vegetable origin. Fish, meat, eggs, milk, fat, etc., belong to the first class, and rice, flour, *dal*, sugar, vegetable oils, fruits, vegetables, etc., come under the second category. Milk and milk-products, although strictly of animal origin, are generally regarded in this country as non-

animal food. We cannot maintain good health by eating meat or rice alone, because, although the former contains considerable quantities of protein and fats, it is more or less deficient in the other nutritive principles of food; while the latter, though containing a very large proportion of carbo-hydrates, is very deficient in proteins, fats and salts. So either of these taken alone as food does not supply the needs of the body. It is only by making a careful selection of the different kinds of food-stuffs of animal and vegetable origin that we are able to maintain our body in a state of perfect health and fitness.

CHAPTER IV

VITAMINS.

Within the last few years, a great change has taken place in our conception of the part food plays in the nutritional requirements of our body.

Only twenty years back, physiologists all over the world thought that the supply of the five proximate principles of food, *viz.*, proteins, fats, carbohydrates, salts and water, of proper quality and in adequate quantity, was all that was needed for helping the growth and repair of the body and to keep it at the proper standard of health and in full activity. Due regard was always paid to the selection of foodstuffs in respect of their quality and variety, and to securing a well-balanced distribution of the various nutritive principles in the daily diet according to age and requirements under different conditions of life and climate.

Feeding experiments on men and animals have since proved that these so-called nutritive principles of food when taken in chemically pure condition in an otherwise well-balanced diet of correct energy-value, would not by themselves suffice to keep the animal in a normal state of health, but would, before long, stop its growth, induce loss of weight and bring on an abnormal condition of blood and other

tissues of the body leading to various kinds of disease and death.

It has now been found that in addition to the five nutritive principles of food already mentioned, certain other substances which are present in very small quantity in most of our food-stuffs in their natural condition, must be taken along with these five principles, as without the former, no growth can take place, good health cannot be maintained and diseases cannot be prevented. These substances have been proved to be indispensable constituents of a healthy diet and have been named as "Vitamines" by Funk, or " Accessory Food Factors " by Hopkins. The chemical nature of these substances has not yet been fully ascertained, nor is their mode of action in the system yet definitely known. The subject is being vigorously investigated into in all parts of the world.

Discovery of Vitamins.—The fact that absence of fresh fruits and vegetables in daily diet is the cause of scurvy has long been known. When Vasco Da Gama came to India round the Cape of Good Hope in the 16th century, his sailors suffered terribly from scurvy. Out of 160 men he had with him on the voyage, one hundred died from the effects of scurvy before he reached India. In those days of long voyages by sailing ships, there was great scarcity of fresh fruits and vegetables in the ship and this accounted for the outbreak of the fatal disease among the crew.

In 1734, it was Bachstrom who first observed that a total abstinence from fresh vegetable food and greens was alone the true primary cause of scurvy.

In 1755, Dr. James Lind wrote that more men in an army in a prolonged war were killed by scurvy than by the sword, and he endorsed the opinion of Bachstrom that absence of fresh fruits and vegetables was responsible for outbreaks of scurvy.

In certain parts of England during the middle ages, people in winter months could not get sufficient quantity of fresh fruits and vegetables and had to live mostly on salted meat. The result was that there was a very large incidence of scurvy in London at that time and Harvey styled the disease as the "Disease of London." Improvement in gardening and agriculture, however, made the disease disappear from the English soil.

In 1747, the celebrated Captain Cook made certain experiments on his sailors for prevention and cure of scurvy by adding oranges and lemons to their ordinary sea-faring diet. The addition of these fruits not only prevented out-breaks of scurvy, but cured the sufferers within a short time. For this good work, Capt. Cook was awarded the Copley medal by the Royal Society. Subsequent experiments have established beyond doubt the just claim of lemon juice both as a preventive and cure of scurvy. In 1795, the Admiralty ordered that all His Majesty's ships should be provided with lemon juice before going out to voyage..

There was a severe out-break of Beri-beri and Scurvy among the British and Indian troops in Mesopotamia during the last Great European War and thousands were disabled within a short time. The military authorities approached the scientists in

England for the prevention and cure of these two maladies.

All praise and honour are due to an English lady, Miss Chick, and a few English scientists such as Hume, Cooper, Prof. Harden and others, who took up the enquiry in right earnest and started feeding experiments on animals in the Lister Institute to determine the comparative anti-Beri-beri and anti-Scorbutic values of various kinds of food-stuffs. As a result of their laborious experiments, sprouting grains (grams, peas, lentils and other kind of pulses) and an extract of yeast were found to be rich in vitamins "B," and "C," and these were successfully used among the British and Indian troops as preventives of Scurvy and Beri-beri. The effect was marvellous. The out-break was speedily checked, and the victims rapidly recovered.

In 1881, Lunin fed some mice upon specially prepared (purified) milk-fat, casein, cane-sugar and salts. The diet was well-balanced and of correct energy-value. But the animals all died within 26 days. Mice fed on whole milk, however, lived and grew normally. These experiments led him to conclude that besides the proximate principles, natural milk contains some other substance or substances indispensable for nourishment and growth of the body. It was in the year 1897 that Eijkman fed a number of pigeons on milled or polished rice alone and it was found that the birds began to suffer after a time from a condition of paralysis resembling Beri-beri in man. He concluded that unpolished rice contained something which prevented the incidence of the patholo-

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gical condition brought on by polished rice. Funk found in 1910 that there were many other food-articles which contained this and similar other vital principles necessary for maintenance of health and vitality and he renamed them *Vitamines*.

Hopkins carried on a large number of feeding experiments on animals which he published in 1912. He took one set of rats and fed them on chemically pure casein, lard, sugar, and salts in sufficient quantity. He fed a second set of rats exactly on the same diet with the addition of 2 to 4 cc. of milk with it per diem. The first set of rats was found to decline in weight within 15 days, but the second set maintained normal growth throughout.

In the second experiment, Hopkins took a set of 8 rats which were fed on the purified diet of the previous experiment for 18 days, and then this was stopped and they were fed on *whole milk* alone. The result was that the rats first declined in weight, but began to gain weight as soon as they were put on *whole milk* after the 18th day. Hopkins next took another set of 8 rats and put them on the purified diet and *whole milk* for 18 days, after which the *whole milk* was discontinued. The result was that the growth continued to be normal so long as *whole milk* formed part of the diet, but the animals began to lose weight as soon as it was discontinued after the 18th day.

The above experiments clearly proved that there was something in the *whole milk*, which sustained nutrition and growth but which was absent in the nutritive principles of milk subjected to purification.

McCallum and Davis found that butter-fat, dissolved out with ether, contained something else than fat which secured prolonged growth in animals when added to diets which otherwise would not support growth. It was also found that the yellow of egg possessed the same property which was absent in lard and olive oil.

Stepp conducted a number of experiments on rats in Germany to find out if animals could live without fat and lipoids in their food. He look a set of mice and put them on bread and milk. All the animals showed normal growth. In the next experiment, he fed some mice with bread and milk, after extracting the latter with alcohol and ether. These animals died after a few days. In the third experiment, he fed a number of mice on exactly the same diet as used in the second experiment, but in addition, he gave the animals the dried alcoholic and ethereal extract of the milk as well. These animals lived and their growth was normal. In his fourth experiment, he fed a number of mice on the same diet as used in the second experiment and he added to it certain fats and lipoids. The result was that all the animals died within a few days.

Stepp came to the conclusion that it was not fat or lipoids which helped growth, but it was something which was contained in the fat and which remained in solution in it.

In 1911, Osbourne and Mendel carried out a large number of feeding experiments on rats in America to study the quality of proteins in nutrition. They used *purified* protein, lard (*pure* fat) *pure*

milk-sugar and starch (for carbo-hydrates) and a mixture of salts. Health was maintained for sometime and then the animals began to decline (1st experiment); but they began to grow again as soon as an ether extract of egg or butter was given to them (2nd experiment). But it was found that ethereal extracts of such fats as lard, cotton-seed oil or olive oil had no effect on them. Osbourne and Mendel concluded that *something* was taken up by ether from egg and butter over and above the fat, *which* helped the growth of the animals and maintained them in health in the second experiment.

Vitamin " *A*."—The results of experiments of these workers proved that there were two classes of fats—*good* fats and *bad* fats—the first class help growth but the last class possess no influence on it. It has since been conclusively proved that the *good* fats to which cod-liver oil, butter, egg yolk, etc., belong, contain one of the most important vitamins called the fat-soluble vitamin " A," but the *bad* fats such as lard, almond oil, cotton-seed oil, olive oil, etc., are wanting in it, and that it is this vitamin " A " and not the fat in which it is found, which helps growth of the body. Vitamin " A " has since been split up into " A " and " D," the former promoting growth in general, resisting infection and preventing certain eye-affections, while the main function of the latter (" D ") is to help the formation of bones and prevent the incidence of rickets in children.

McCallum and Davis, also American workers, made independent experiments on rats on similar

lines and their results coincided with those of Osbourne and Mendel.

These experiments led people to believe that the only essentially growth-promoting substance was to be found in good fats. Besides cod-liver oil and yolk of egg, fat fish, fish roe, butter, *ghee*, mutton fat, whole milk and green leafy vegetables are rich in vitamin " A."

Vitamin " B."—McCallum and other workers in the course of their feeding experiments on animals found that there was another essential factor contained in foods other than fats which also promoted growth in animals. This second substance is present in wheat, pulses, rice, in other cereals and in yeast. As it is soluble in water, it is called water-soluble Vitamin " B." Lack of this vitamin in diet was subsequently found to be the cause of Beri-beri in men and polyneuritis in birds. Vitamin " B " has since been split up into B^1 and B^2; the former possesses anti-neuritic properties preventing *Beri-beri*, and the latter prevents the incidence of another disease called *Pellagra*, prevalent among the peasantry in North Italy.

Numerous feeding experiments on men and animals made by Funk, Vedder, Fraser and Stanton, McCarrison, and others have established beyond doubt the identity of vitamin B with the anti-Beri-beri factor.

Vitamin " C."—Later on, it was found that although rats could live and grow on diet containing purified proteins, fats, carbo-hydrates and salts with

some other foods containing vitamins A and B, men could not live and thrive on such a diet. Such a diet produced scurvy in them. Subsequent experiments established the fact that a third essential growth-promoting factor other than vitamins A and B must be present in the food of man, as otherwise his health would break down and he would get *scurvy*. This third essential factor is found to be present in large quantity in fresh fruits and vegetables; it is soluble in water and is called water-soluble Vitamin C or the anti-scorbutic food-factor.

Vitamin "*D*."—Recently, substances such as cod-liver oil, fat, yolk of egg, etc., which are rich in vitamin A have been found to contain another vitamin quite distinct from A. This has been found to promote the growth of bones and teeth and prevent the incidence of *rickets* in children. This has been named as vitamin "D" or anti-rachitic vitamin. Cod-liver oil and other fish oils, butter, *ghee*, green leafy vegetables, oranges and tomatoes contain a large proportion of this kind of vitamin and are used as preventive and curative agents in *rickets*. Ground-nut oil and cocoanut oil contain a little of it, while other vegetable oils contain none at all. Exposure to sunlight and to ultra-violet rays is favourable to the growth of this vitamin in animals. Certain fats and allied substances devoid of vitamin D have been found to develop this vitamin when exposed to ultra-violet rays and would thus possess anti-rachitic properties. This vitamin is also produced by the action of sun's rays on our skin. Indian children constantly exposed to sun's rays suffer little from rickets, while in England where sunlight is

scarce, incidence of rickets in children is very common.

Vitamin "E."—Only recently, the presence of a new vitamin in wheat and in a few other food-stuffs has been ascertained, the absence of which in food would cause sterility in animals or failure to rear the young. This has been named vitamin "E."

Properties of Vitamins.—The chemistry of any of the five vitamins is not yet definitely known. The difficulty lies in the extremely small quantity in which they exist in the food-stuffs, which stands in the way of collecting an adequate quantity for experimental purposes. The rice-polishings, for example, contain vitamin B and Funk tried to isolate it from this substance. He succeeded in separating about 10 grains only of a crystalline substance from 1 to 1½ maunds of rice-polishings to which he ascribed the formula $C_{17}\ H_{18}\ O_4\ N$ and named it "Vitamine." It was found to possess marked anti-Beri-beri properties; about ½ grain of this substance was sufficient to cure a pigeon of poly-neuritis. Even then Funk thought that the substance he had separated was not a single substance, that it was not pure but that it was mixed with other matters.

As already stated, vitamin A is associated with fat, but it is not fat. It is not saponified by alcoholic potash. At one time, vitamin A was considered to be identical with the yellow pigment of yolk of egg and butter fat; later experiments have not established the identity. It resists heat up to about 120°C., but if air is bubbled through it during

heating, it is rapidly destroyed. It is in this way that vitamin D has been separated from vitamin A in cod-liver oil. If the oil is heated and a current of oxygen passed through it, vitamin A is destroyed, but D remains there. If the oil is now saponified and extracted with ether, the ethereal solution takes up the vitamin D. It is completely destroyed by hydrogenation; therefore, vegetable margarine or vegetable *ghee* does not contain this vitamin. It is activated by exposure in thin layers to ultra-violet rays from 5 to 8 hours. It is destroyed by keeping. It is soluble in alcohol, ether and benzene. An ethereal extract of this vitamin may be made from dry green leaves. Vitamin A is not increased by germination of seeds. This vitamin is not found in vegetable oils or in lard, but is abundantly present in cod-liver oil, butter-fat, milk, egg yolk, spinach, lettuce, cabbage, cauliflower, tomatoes, etc. When cows feed on green pastures, the milk yielded by them is rich in vitamin A.

Vitamin A is essential to growth. Deficiency of this vitamin in diet increases susceptibility to infection and leads to certain diseases of the eye (Xerophthalmia, night-blindness). It also helps the proper functioning of intestinal epithelium, keeps the blood of proper composition and prevents water collecting in the tissues. Most Indian diets of the present day are deficient in vitamin A.

Vitamin B is the most stable of all vitamins. It is not destroyed by drying. Dry seeds such as pulses and grains retain it for a long time. It stands a temperature of 100°C. It is soluble in

water and in dilute alcohol, but only slightly soluble in absolute alcohol, chloroform, ether, benzene, and acetone. It is not easily destroyed by acids. It may be extracted from rice-polishings by acid alcohol. It is affected by alkalies. If *dal* is boiled in water to which carbonate of soda has been added for softening (as is sometimes done in the case of *hard* water), this vitamin is destroyed.

Vitamin B also promotes growth and its absence causes poly-neuritis in fowls and Beri-beri in man. It is absent in polished rice, and when pigeons are fed on a diet of polished rice alone, they develop poly-neuritis and die. A watery extract of rice-polishings given to the sick birds cures them of the disease. Men suffering from Beri-beri show striking improvement as soon as they are given food rich in vitamin B. It is utilised in the body-growth and repair, and its deficiency or absence in food causes gastro-intestinal disorders and lessens resistance against bacterial invasion. It acts as a stimulant to metabolism and to the action of some of the endocrine glands. It also helps the discharge of waste materials from the body and makes the muscles, nerves and skin do their functions properly. It is found in good quantity in some of the internal organs of animals, namely, brain, liver, kidneys, heart and the intestines.

It is found in abundance in all cereals, pulses, nuts, in the leafy portions of green vegetables, in tomato and in the orange. Milk and eggs contain a small quantity only. Cereal grains, subjected to the process of milling, contain little or no vitamin.

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Of all cereal grains, rice contains the least proportion, while white flour and polished rice are practically wanting in this vitamin.

Vitamin B is destroyed only by prolonged cooking.

Vitamin C is called *anti-scorbutic* vitamin, as its absence causes *scurvy*. It keeps the blood in proper condition and prevents its leakage from the vessels into the tissues. It helps the other vitamins in the building up of bones, teeth and other tissues, and increases the resisting power against infection.

It disappears during the ageing of food-stuffs. Air-drying also destroys this vitamin. The destruction is probably caused by oxidation. It is contained in sour milk, but it disappears rapidly in pasteurised milk.

It is abundant in all green leafy vegetables (cabbage, lettuce, spinach, etc.), in most fresh fruits and in sprouting pulses (gram, peas, etc.). Milk and meat are rather poor in this vitamin. It is contained in abundance in the juice of the lime, orange and lemon, the last two containing a much larger quantity than the first. Tomato is specially rich in this vitamin; canned tomatoes seem to be as effective as the fresh fruits. Vitamin C suffers more when food is cooked for a longer period than when it is kept at a relatively high temperature for a short period of time.

Vitamin D prevents the incidence of *rickets* in children. At one time, deficiency of food

rich in vitamin A was thought to be the causative factor in *rickets*. It has now been proved that absence of vitamin D (which has since been separated from vitamin A) in the diet of children is entirely responsible for the causation of rickets. McCallum has shewn that these two vitamins (A and D) are distinct and it is the vitamin D *and not A* that possesses *anti-rachitic* properties. Deficiency of this vitamin in food leads to early decay of teeth.

Two factors are concerned in the prevention of *rickets*; one is *sunlight* and the other is this *unknown substance* found in abundance in cod-liver oil, which we call vitamin D.

This vitamin is found in large quantity in cod-liver oil and in other fish oils. It is also present in smaller quantity in butter-fat and in cocoanut oil. It is absent in vegetable oils.

Vitamin E is said to be helpful to the process of reproduction. Evans and Bishop had discovered the existence of this vitamin which they named X (now called E), which is distinct from all the other vitamins and which they believed to be an essential factor in stimulating reproduction in animals. It is present in lettuce leaves, cereals, fresh meat (cheek muscle), in certain vegetable oils and in egg-yolk. It is present in its most concentrated form in the oil expressed from the germ of wheat grains. They found that the addition of these substances to the diet of animals suffering from defective reproduction removed sterility in females.

No one vitamin is equivalent to the other. Each of them is an essential food-factor by itself and they cannot be replaced by one another.

Deficiency Diseases.—The absence of these vitamins from food leads to the incidence of the so-called deficiency diseases. Absence of vitamin B is responsible for *Beri-beri*; *Pellagra* is caused by the absence of B^2 in food; a lack of vitamin C in diet causes *scurvy* and of vitamin D produces *rickets*. Insufficiency of vitamin A retards growth, produces night-blindness and other eye diseases and reduces resistance against infection.

None of the vitamins has yet been isolated in a pure form, but certain preparations of these vitamins in crude and concentrated forms have been manufactured, and these are being used medicinally with good results in certain deficiency diseases.

The table on the next page shews the vitamin-contents of some of the more important food-stuffs. The mere presence of vitamin has been indicated by the + (plus) sign, a larger quantity by two plus signs (+ +), and richness in vitamin has been indicated by three or more plus signs (+++) or (++++). Doubtful presence is noted by a sign of interrogation (?) and its absence by a zero (0). Absence of any sign means that the matter has not yet been investigated.

TABLE I.

Food-stuffs	Vitamin A	Vitamin B	Vitamin C	Vitamin D	Vitamin E
Rice ...	+	+	0	...	+
Do. (polished)	0	0	0	...	...
Wheat ...	+	+ +	0	...	+
White flour ...	0	+	...	...	...
Whole meal flour ...	+	+ +	...	...	...
Dal ...	+	+ +	...	...	...
Sprouting grain	+	+ +	+ +	...	...
Sugar	0	0	0	...	...
Goor ...	0	+	0	...	...
Honey ...	+	+	0	...	...
Milk (raw) ...	+ + +	+ +	+	+	...
Do. (boiled) ...	+	+	...	...	...
Curd (*dahi*) ...	+ +	+	+	...	...
Butter ...	+ + +	...	...	+	...
Lard ...	0	0	0	...	...
Beef fat ...	+ +	...	...	...	...
Codliver oil ...	+ + +	?	0	+ + +	...
Coccanut oil ..	+	0	0	+	...
Groundnut oil...	+	0	0	?	...
Olive oil ...	+	0	0	...	...
Mustard oil ...	0	0	0	...	...
Cream ...	+ + +	+ +	...	+	...
Til oil ...	?	0	0	...	...
Vegetable *ghee*	0	0	0	0	...
Margarine ...	0	0	0	...	...
Eggs ...	+ +	+ + +	...	+	+
Meat ...	+	+	+	...	...
Chicken ...	+	+	...	...	...
Liver ...	+ + +	+ + +	+	+	...
Fish ...	+ +	+ +	...	...	...
Almonds ...	+	+ +	...	...	...
Cocoanut kernel	+	+ +	...	...	...
Apple ...	...	+	+	...	...
Plantain ...	+	+	+	...	...
Pineapple ...	...	...	+ +	...	...
Grapes ...	...	+	+	...	...
Limes ...	...	+	+ +	..	...
Lemons ...	...	+	+ + +	...	...
Papaya ...	+	+	+ +	...	...
Oranges ...	+	+ +	+ + +	...	...
Mango ..	+	...	+ +	...	...
Tomato ...	+ +	+ + +	+ + +	...	...
Beans ...	+	+ +	+ +	...	...
Soyabean ...	+	+ +	...	...	...
Cabbage ...	+ + +	+ +	+ + +	...	...
Cauliflower ...	+	+ +	+	...	...
Carrot ...	+ +	+ +	+ +	...	...

TABLE I—*Contd.*

Food-stuffs	Vitamin A	Vitamin B	Vitamin C	Vitamin D	Vitamin E
Lettuce ...	+ +	+ + +	+ +	...	...
Patol ...	...	+	+	...	...
Potato ...	+	+ +	+ +	...	...
Peas (green) ...	+ +	+ +	+	..	...
Spinach (*palong*) ...	+ + +	+ + +	+ + +	...	...
Onion ...	?	+ +	+	...	...
Yeast (*bakhor*)	...	+ + +	...	...	..
Sago ...	0	0	0	...	...
Tapioca ...	0	0	0	...	...
Jams ...	0	0	0	...	...
Tea ...	0	0	0	...	...
Coffee ...	0	0	0	...	...
Condensed milk ...	+	+	...	...	...

CHAPTER V

Digestion, Absorption and Assimilation of Food.

Most of the food we take must undergo some important changes before it could be absorbed and utilised in the system. Only water, salts and some substances such as glucose, etc., are absorbed without change by the blood vessels, but it is not so with proteins, fats and most of the carbo-hydrates which must pass through certain changes before they could be taken up by the blood for the use of the body. The whole process of digestion, absorption and assimilation of food is carried on by certain special organs of the body known as the digestive organs.

The digestion of food takes place in a long tubal passage of which the *mouth* forms the entrance, and the *anus*, its exit. The diameter of the tube is not uniform throughout. Its entrance (the mouth) is a large cavity furnished with a set of grinding apparatus for reducing fragments of hard and solid food into smaller divisions, and this is mostly done by the two sets of teeth imbedded in the upper and lower jaws. The upper and back part of the mouth is called the *pharynx*, and this opens into a very narrow canal known by the name of *œsophagus* or *gullet* which is about 10 inches long. The gullet lies immediately behind the voice-organ and the wind-pipe which form together the passage for entrance of air into the lungs. This passage is provided with a lid

at its upper part, which closes automatically on the approach of food which it allows to glide over its smooth upper surface and pass downwards into the gullet (the food-passage). This automatic closing of the lid prevents the entrance of any particle of food into the air-passage. Accidental introduction of food or other foreign matters into the air-passage gives rise to distressing cough and difficulty of breathing, not un-often attended with fatal results.

The widest part of the digestive canal is the stomach into which the gullet opens. It resembles in shape the leather-bag (*Masak*) of an Indian water-carrier (*Bhisti*).

The stomach opens into the small intestine which is the longest part of the tube (about 21 feet in length) and this is succeeded by the large intestine which is shorter (about 6 feet long) but much wider than the small intestine.

The *small intestine* consists of three parts. The upper part is the *duodenum* (from 8 to 10 inches long), the middle part is called the *jejunum* (about 9 ft. in length) and the lower-most part is known as the *ileum* which is about 11 ft. long. The two important organs of digestion, the *liver* and the *pancreas*, open into the *duodenum* by a common duct and discharge into it the digestive juices called the *bile* and the *pancreatic juice*, secreted respectively by the two organs. These play an important part in the digestion of food.

The *small intestine* is connected with the *large intestine* by means of a pouch-like cavity called the *cæcum* which is provided with a valve (*ileo-cæcal valve*) acting like a door which allows the forward

passage of the contents of the small intestine into the large intestine but prevents its backward flow from it. To the cæcum is attached a pendant structure called the *appendix vermiformis*, the exact function of which is not known; its inflammation gives rise to the well-known disease called *appendicitis*. The whole process of digestion is finished in the small intestine.

The *large intestine* consists of an *ascending*, a *transverse* and a *descending* portion, known as the *ascending*, *transverse* and *descending colons*, followed by an S-shaped portion (the *sigmoid flexure*) which ends in the *rectum* where fæcal matter accumulates before evacuation. The lower opening of the digestive canal is called the *anus* which ordinarily remains closed by the action of constrictor muscles but which opens in due time to allow the passage outside of fæcal matter.

The mechanical part of digestion is practically wholly done in the mouth. The teeth helped by the tongue and the muscles of the cheek and the palate not only reduce the solid food we take to a fine state of division but cause it to mix intimately with *saliva* (a digestive juice secreted by certain glands situated in or near the cavity of the mouth) which converts the starch of the food, first into (1) *dextrin*, and then into (2) *maltose*. This is the first digestive process to which the food is subjected on its entrance into the digestive canal. Starch must be converted into glucose before it could be taken up and utilised in the system, and *maltose* (after dextrin) is the first change brought about in starch by an amy-

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lolytic ferment called *ptyalin* contained in saliva. Maltose is ultimately converted into glucose in the small intestine by another ferment. The intimate mixing of the saliva with food is known as *insalivation*.

Saliva is a colourless slightly opalescent fluid, alkaline in reaction, secreted by four salivary glands (the two *parotids*, the *submaxillary* and the *sublingual*). The two parotids are situated inside and behind the lower jaw at its sides and angles, and the other two are located behind the chin and under the tongue. They open into the cavity of the mouth by separate ducts. The presence of food in the mouth (and sometimes even the sight of it) stimulates these glands, causing them to discharge their secretion (*saliva*) in copious quantity into the mouth. The saliva should freely mix with the food, thus rendering it into a soft pulpy mass for easy deglutition and helping partial digestion of its starchy contents. There are numerous other small glands situated at the upper and back part of the mouth (called the pharynx) which secretes a colourless viscid liquid substance called *mucus* which thoroughly coats the bolus of food and helps the slimy lump to slide down easily through the narrow gullet into the stomach. Thorough mastication of food is very necessary, as without it, food is not reduced to fine division and this would prevent its being penetrated and fully acted upon by the various digestive juices. Food should, therefore, be eaten slowly and well-subjected to the action of the teeth. Loss of teeth in old age is a great hindrance to good digestion and often gives rise to dyspeptic troubles. The muscles of the

pharynx, acting upon the bolus of food from the front push it backwards and downwards into the gullet in its passage to the stomach.

The digestion of protein-matters in the food begins as soon as it reaches the stomach. The inside of the stomach presents a honeycomb-like appearance under the microscope, each cell being studded with orifices which are the mouths of numerous glands situated in the wall of the stomach. These glands secrete a digestive juice called the *gastric juice* containing a ferment called *pepsin* and a *free* acid called *hydrochloric acid*. Pepsin, in presence of hydrochloric acid, acts upon the protein-element of food; it has no action on starch, sugar or fat. The proteins of meat, fish, milk, egg, wheat, rice, fruits, vegetables, etc., are converted by the ferment of the gastric juice, first into *acid meta-proteins*, then into *proteoses* and finally into *peptones*, by a process of hydrolysis. The digestion of starch by saliva which begins in the mouth, goes on for a short while after the food reaches the stomach but it then stops in the presence of the acid gastric juice, and it does not commence again until the food reaches the small intestine. According to some authorities, digestion of *fat* goes on to a very slight extent in the stomach with the help of a ferment called *lipase* secreted by the organ. The principal function of the stomach, however, is the digestion of proteins. Cane-sugar in the food is partly converted into grape-sugar in the stomach by the action of free hydrochloric acid in the gastric juice. *Rennin* is another ferment secreted by the stomach which has the property of curdling milk.

The distal end of the stomach (*pylorus*) remains firmly closed by means of a circular set of muscles, until the digestion in the stomach is completed. There are muscles in the wall of the stomach which cause it to move and operate upon its contents, thus helping the food to mix intimately with the gastric juice. The partially-digested food in the stomach is a muddy-looking thick pasty substance known by the name of *chyme*.

As soon as digestion in the stomach is completed, its distal end (*pylorus*) relaxes and the chyme gradually passes into the upper part of the small intestine (*duodenum*) to undergo further digestive changes. The average time for digestion of a full meal in the stomach is about 3 hours. If there is much fluid in the food, it leaves the stomach more quickly. People suffering for want of nourishment are rapidly restored by administration of liquid food than solid food, which thus quickly passes into the small intestine and gets absorbed into the system.

Practically, no food, not even water, is absorbed in the mouth or gullet, and only slightly in the stomach. It is in the small intestine that the process of digestion is completed and the products absorbed into the system through different channels, absorption beginning in the duodenum. Proteins, sugars and salts are absorbed by blood-vessels, and fat is taken up by another set of vessels called *lacteals* or *lymphatic channels*. No digestion goes on in the large intestine. Absorption, however, specially of water, occurs in the large intestine to some extent.

The digestive processes in the different parts of the digestive canal appear to be inter-dependant upon one another. The conversion of starch into dextrin in the mouth helps the formation of a substance called *gastrin* in the stomach, which, in its turn, stimulates the secretion of the gastric juice. The acid character of the chyme in the stomach helps the production of another substance called *secretin* in the duodenum, which being taken by the blood to the pancreas, stimulates the flow of the pancreatic juice. These substances are known by the name of *hormones*, and they play an important part in the digestion of food. They resemble in their character the secretions from the various endocrine glands, such as the thyroid, the pituitary body, the adrenals, etc.

As soon as food reaches the duodenum, it is neutralised by the juice secreted therefrom (which is alkaline in reaction), and then it is acted upon by the bile and the pancreatic juice. The *peptones* coming into contact with the pancreatic juice are at first changed into *polypeptides* and then into various *amino-acids* by *trypsin*, a ferment contained in the pancreatic juice. The juice secreted by the small intestine is called *succus entericus* which contains, among others such as *invertase*, *maltose*, etc., two ferments known as *enterokinase* and *erepsin* which are strongly proteolytic in their action, and these help the action of *trypsin* in the conversion of peptones into amino-acids which constitute the final cleavage-products of the digestion of protein. The amino-acids are absorbed by blood-vessels and taken through liver to all parts of the body when they are

taken up by the selective action of the tissues and form *tissue-proteins* by linkage. The tissue-protein is not the same as the food-protein we take, which may vary widely in its composition. Food-protein is broken up into various kinds of amino-acids, such as glycine, leucine, tyrosine, tryptophane, alanine, lysine, etc. The tissues, by their selective action, take up those amino-acids only which they need for their growth and repair, and which, by linkage, build up the particular tissue-protein. The amino-acids are like bricks used for the construction of a building; the tissues, like masons, select the kind of bricks which fit in for the building up of the special structure. As a rule, we ingest more protein than what is necessary for the building up of the tissue-proteins. When carbo-hydrates in the diet are in proper quantity, protein is not utilised in the system for production of heat and energy. The excess amount is taken up by the liver and converted into *urea* which is excreted by the kidneys as a waste-product.

The fat of the food is acted upon by both the bile and the pancreatic juice in the small intestine and is first emulsified and then saponified (turned into soap). An enzyme called *lipase*, present in the pancreatic juice, splits the fat into fatty acids and glycerine. The fatty acids combine with alkalis to form soaps, and both these and the glycerine are absorbed in the presence of bile by the intestinal cells and reformed into fat which is then taken up by a special set of vessels known as *lymphatic* vessels. These are distributed over minute soft velvety prominences in the intestinal wall, called the *villi*.

These lymphatic vessels are also called *lacteals*, owing to the milky character of their contents. The lacteals lead to a larger vessel called the *thoracic duct* which empties its contents into the blood-stream.

The digested food at this stage assumes the appearance of thick milk and is known by the name of *chyle*. Bile-acids help the pancreatic juice in the digestion of fat. Persons suffering from liver-disorders usually pass whitish stools owing to deficiency of bile-secretion and these often contain much undigested fat. Bile also helps in the digestion of proteins and carbo-hydrates.

Liver is one of the most important digestive organs. It has further the power to keep out toxic substances, whether introduced from outside, such as arsenic, lead, opium, strychnine, etc., in cases of poisoning, or developed in the course of mal-digestion of food, thus protecting the system from their baneful effects. It is said that such potent poisons as arsenic, etc., would require a double dose to kill an animal *with liver* than *without it*. Liver is also an eliminatory organ; it gets rid of some of the waste-products of the body. It is also the storehouse of glycogen manufactured from starch and sugar contained in our food, and it helps in the disposal of the dead blood-corpuscles. The bile secreted by the liver also acts as an antiseptic of the intestinal canal.

Digestion of the carbo-hydrate-contents of the food recommences in the small intestine. It has already been mentioned that the *ptyalin* of the saliva converts part of the starch in the food into maltose in the mouth, but this action stops shortly

after the food enters the stomach. The pancreatic juice contains another ferment called *amylase* which converts the remainder of the starch in the food into maltose, and then into glucose, and all the cane-sugar present in the food is also turned into glucose and levulose by a ferment called *invertase* present in the intestinal juice. Milk sugar (lactose) is similarly acted upon by another ferment called *lactase*. These are then absorbed by the blood-vessels and carried to the liver where they are converted into glycogen, and there stored up for the future use of the body. This stored glycogen is let off by the liver into the blood-stream as glucose, according to the requirements of the system. The glucose contained in the blood-stream undergoes combustion for the production of heat and energy. This burning of sugar in the blood is helped by *insulin* which is an internal secretion (*hormone*) of the pancreas. If from any cause, less insulin is produced in the body, or if the liver fails to convert the whole of the sugar contained in the digested food into glycogen, blood-sugar is increased, and when it crosses the *thresh-hold level* of the kidneys, sugar appears in the urine constituting the disease known as *glycosuria* or *diabetes*.

As already stated, the large intestine does not take any part in the digestion of food. Its main function is the storage of fœces and their evacuation at due intervals. Absorption of fluid (water), salts and glucose, however, goes on slowly in this part of the digestive canal, and the secretion from its glands, mixing with the contents, imparts to it the peculiar fœcal odour. The fœcal matter by ab-

sorption of fluid gradually obtains its usual consistency as it reaches the *rectum* which is guarded by constricting muscular fibres at its lower end (called the *anus*). The nervous mechanism in the rectum is stimulated by the presence of accumulated fœces (which act as foreign matter), the muscular fibres are relaxed by reflex action and defæcation takes place in proper time.

Excreta should contain no digested food, but only its undigested residue. But owing to faulty digestion, ingestion of unsuitable food and other causes, more or less undigested and undigestible food is often found in the fœces. It is also mixed up largely with intestinal epithelium and bacteria, the latter forming about one-third of its total weight. The undigestible food consists mostly of cellulose which adds to the bulk of the excreta and helps as a mechanical stimulant in the evacuation of the bowels. A certain quantity of cellulose should, therefore, be present in our food for relief of constipation and may best be obtained by taking a liberal quantity of fresh fruits and vegetables. Vegetarians throw out a much larger quantity of fœcal matter than persons living principally on animal food. The question of disposal of human excreta is, therefore, much more complex in a tropical country where people live mostly on vegetable food than in temperate and cold climates where meat and other animal foods are chiefly used.

CHAPTER VI

Data for Construction of a Proper Dietary—Table of Food-values.

We now propose to consider in what proportions the different nutritive principles of food should be present in the dietary of a person engaged in ordinary pursuits of life in order to maintain health and physical fitness at the proper standard. We shall also deal with the quantities of different food-stuffs which would supply those principles in the required proportions.

We have already indicated that we need food in order (1) to promote growth and help repair, and (2) to supply heat and energy for internal and external work. Various methods based (1) on experiments on human beings and lower animals, (2) on clinical observations, and (3) on an examination of extensive statistics of dietaries in use among large communities of men in different parts of the world engaged in various pursuits of life, have been suggested for arriving at a correct solution as to the actual quantities of the various nutritive principles required by men and women living under varying conditions of life and climate. For obvious reasons, none of these methods can be pronounced as absolutely correct, although each of them possesses a special value of its own. I do not propose to enter into a detailed consideration of these methods in the

short course of my lectures. I shall make a passing reference only to their more important features.

In order properly to understand the principle underlying the construction of dietaries for individuals as well as for communities, the metabolic activity of the body should engage our first consideration. The word metabolism "is used to express the sum-total of the chemical changes that occur in the living tissues." Metabolic activity is lowest when the body is in complete rest and without food. At such a time, the heat-production and mechanical work due to the activity of the various internal organs, such as heart, lungs, brain, etc., are at the irreducible minimum and the influence of food as a stimulus (known as its *specific dynamic action*) is absent. This lowest rate of energy-exchange is what is called *basal metabolism*, which furnishes the starting point from which proceed all calculations of the nutritive requirements of an individual. It is expressed in the number of units of heat, known as *calories*, liberated from the body of an individual per hour or per day. The rate is proportional to the surface-area of the body, age being one of the determining factors.

It has been estimated that the *basal metabolic rate* of a man between the ages of 20 and 50, with a body of average size and weight, is approximately 39·7 calories per hour per square meter of the body-surface. A meter is a French measure of length and is equivalent to 39·3 English inches. The figure for women is about 36·9 calories only. A calorie is defined as the amount of heat needed to raise the temperature of one kilogramme of water from

0°C. to 1°C. The above rates have, for all practical purposes, been found to be constant. A rough estimate of a person's basal metabolic activity can, however, be made from his body-weight. The basal metabolism for 24 hours of an adult person of average weight and size is approximately 24 calories per kilogramme of his body-weight or 1 calorie per kilogramme per hour. It should be noted that, although, for clinical purposes, the body-weight of an individual may be made to serve as a convenient basis for ascertaining his metabolic activity, for a scientific study of the subject, the surface-area should form the safer criterion for making the calculation.

In estimating a person's fuel requirements, there should be added to the number of calories, necessary for *basal metabolism*, a sufficient number of calories to cover his ordinary activities and the particular work in which he is engaged. For instance, the change from a lying-down posture to sitting on a chair, or the mere act of standing, materially increases the metabolic rate; this increase has been estimated as 10 per cent. of the basal figure. The act of getting out of bed and dressing is estimated as adding about 150 calories. Walking along a level road at the rate of three miles an hour (the maximum of economic velocity) necessitates a metabolic increase of 1·1 calorie an hour for each pound of body-weight moved. This applies to the carriage of extra weights in the same measure as it applies to body-weight.

Carpenter found that the work of typewriting resulted in an increase of from 30 to 70 per cent. in the total metabolism above that of the resting

periods, *i.e.*, an average increase of about 50 per cent. The variations noted in different persons were due to differences in facility and, therefore, to effort. The following two tables give the number of extra calories required per hour by men and women of the West to meet the demands on energy made by various occupations :—

TABLE II.—*Extra Calories per hour attributable to Occupations of Men (G. Lusk—" Science of Nutrition ").*

Occupation of Men.	Extra Calories of Metabolism per hour due to Occupation.
Tailor	44
Book-binder	81
Shoe-maker	90
Metal-worker filling and hammering	141
Painter of furniture	145
Carpenter making a table ...	164
Stone-mason chiselling tombstone ...	300
Man sawing wood	378

TABLE III.—*Extra Calories per hour attributable to Occupations of Women (G. Lusk—" Science of Nutrition ").*

Occupation of Women.	Extra Calories of Metabolism per hour due to Occupation.
Seamstress, needle-work	6
Typist, 50 words per minute ...	24
Seamstress, using sewing machine ...	57
Book-binder	63
Housemaid (moderate work *) ...	81
Laundress (moderate work *) ...	124
Housemaid (hard work *)	157
Laundress (hard work)	214

* Cleaning windows and floors, scouring knives, forks and spoons, scouring copper and iron pots.

According to Sansum's estimate, the calorific requirements for adults are :—

1,000 to 1,200 calories	...	For a person at absolute rest in bed.
2,000 to 2,500 ,,	...	For men engaged in light work, such as professional duties, office work, etc.
3,500 ,,	...	For a man engaged in hard manual labour.
5,500 ,,	...	Constitute the fighting ration of the Armies of the United States, Great Britain and Germany.
8,000 ,,	...	For an Arctic explorer.

For an invalid, 1,500 calories are usually required.

The caloric requirements of children, taking surface-area as the basis for calculation, are higher than those of a grown-up person. They may be roughly put down as follows :—

700 to 1,000 calories	...	Up to 1 year of age.
1,200 ,,	...	From 1 to 2 years of age.
1,500 ,,	...	From 2 to 5 years of age.
1,500 to 2,500 ,,	...	From 5 to 10 years of age.

The following table compiled from McLester's book on "*Nutrition and Diet*" shows the total fuel requirements of people engaged in various occupations. These are figures of Becker and Hamalainen which are generally accepted :—

TABLE IV

Occupations.	Calories.
For Men :—	
Tailors	2,600-2,800
Book-binders	3,000
Shoe-makers	3,100
Metal-workers	3,400-3,500
Painters	3,500-3,600
Cabinet-makers	Do. do.
Farmers	Do. do.
Stone-masons	4,700-5,200
Wood-sawers	5,500-6,000

TABLE IV—(*contd.*)

Occupations.	Calories.
For Women :—	
Seamstress (with hand-needle)	2,000
Seamstress (with machine) ...	2,100-2,300
Book-binders	Do. do.
Household servants ...	2,500-3,200
Washer-women	2,900-3,700

There is another method whereby the food-requirements of an individual can be ascertained with a reasonable degree of accuracy. If we experimentally determine in the laboratory the amount of the various waste-products daily thrown out of our system, it would give us a fair idea of the amounts of the nutritive principles of food which would be required in 24 hours to make up the loss. In addition to this, due allowance for extra quantity of protein and energy in the case of young persons and children must be made to supply building materials in the growing period of their life and to meet the incessant activities of youthful life. By the use of an apparatus called the *Respiration Calorimeter*, the amount of carbon thrown out of the body in the form of carbonic acid gas in 24 hours can be accurately determined, and the amount of heat evolved out of the body during the same period can also be accurately measured and expressed in calories. This heat is produced by the slow combustion in the blood of the protein, fat and carbo-hydrate constituents of our food. The salts and water take no part in its generation, and the vitamins stimulate the metabolic activity only.

By estimating the amount of urea and other nitrogenous waste-products of the body, we can find out the amount of nitrogen daily eliminated from our

system. This amount must be supplied to the body in the shape of *protein alone,* contained in our food, as no other principles of food contain nitrogen.

By the use of another apparatus called the "*Bomb Calorimeter,*" we can find out the amount of heat in calories yielded by a given weight of the different food-substances. It has thus been ascertained in the laboratory, that one gramme of protein yield 4·1, one gramme of fat 9·4, and one gramme of carbo-hydrates 4·1 calories of heat, all *water-free*. If we, therefore, determine the percentages of protein, fat and carbo-hydrates contained in our various food-stuffs, we can easily calculate the amount of heat in calories which a weighed quantity (say, an ounce) would yield on combustion and this would help us in fixing the quantities of the different kinds of food-stuffs we would daily require to supply the energy-needs of the body in the different conditions of life.

It has been experimentally determined that an individual of average height and weight and engaged in ordinary work eliminates, on an average, 300 grains of nitrogen, 4,500 grains of carbon and 2,800 calories (heat units) from his system in 24 hours. There should be enough protein, fat and carbo-hydrates in his daily food, to make up this loss.

As regards the method based on an examination of *statistics*, Rosewarne in his book on "*The Science of Nutrition Simplified*" observes as follows :—" Statistical methods have been employed in Dietetics and have provided extremely valuable guidance. The outstanding examples of this method is that in which the freely selected dietaries of

special groups of people, such as a distinct class of workers, living under the same conditions in every respect, are carefully tabulated; the average amounts of the different nutrients they consume are worked out and the standard requirements for a definite and continuous output of energy are thereby fixed. Remarkably accurate results have been obtained by this method, particularly by the American Department of Agriculture."

The same author commenting on the method of calculating dietaries, based on clinical observations, remarks that it provides a great mass of evidence, particularly concerning the relative value of different food-substances. The scarcity of animal fats in the diet of the people in many European countries, during and after the War, involved a deficiency of the vitamins (which promote growth and the formation of bones), with the result that an enormous number of children became stunted and deformed. He further says that the study of diabetes has been prolific in discoveries relating to the proper utilisation of protein, carbo-hydrates and fats, and the necessity of preserving a balance of these nutrients in the dietary.

Basing their calculations on the results of the above-noted investigations, most physiologists are now agreed that, for an adult person of average height and weight, engaged in ordinary work and taking a moderate amount of exercise, the daily requirements of nutrients should be from 90 to 100 grammes of protein, 60 to 80 grammes of fat and from 450 to

475 grammes of carbo-hydrates, which would yield him an energy-value of about 3,000 calories for both internal and external work. His daily dietary should, therefore, be so constructed as to furnish him with these amounts of nutrients and energy in order to keep him in full vigour of health and activity. For people of greater height and heavier weight or for those engaged in hard manual labour, a larger quantity of the different nutrients would be required, and the quantity of daily food should correspondingly be increased. Women usually consume food nearly 1/10 less in quantity than men, but children (being in the growing period of life and being more active) require an extra quantity of both protein and energy over and above that indicated by the surface-area of their body, to supply the needs for growth and extra activities.

From the available data, it appears that the average height and weight in the majority of the Indian races is lower than that of the Europeans. We shall not, therefore, be far outside the correct estimate if we fix 90 grammes (about 3 ounces) of *water-free* protein, 60-70 grammes (about 2 ounces) of *water-free* fat and 475 grammes (about 16 ounces) of *water-free* carbo-hydrates as the minimum daily requirements of these three nutrients for a young adult Indian of average height and weight, engaged in ordinary pursuits of life and taking a moderate amount of exercise, which would yield him an energy value of 2,874 calories per day.

It should be noted here that a small class of physiologists headed by Chittenden maintains that it is quite possible to keep oneself in perfect health

and activity by consuming not more than half the quantity of protein (*i.e.*, from 40 to 50 grammes or about 1½ ounces) usually prescribed by the majority of physiologists. In the opinion of Chittenden, the large quantity of protein which is usually consumed by men is not only a great waste from an economic point of view but it also unduly taxes the capacity of the organs of the system concerned in its final disposal. We shall discuss this subject briefly later on when speaking of the defects of the present-day Bengalee diet. It is sufficient for our purpose to say here that we cannot accept Chittenden's view for the following reasons:—

(1) It does not receive the support of the most accredited authorities on the subject in Europe and in America, as will be seen from the annexed table.

TABLE V

Showing the daily amount of protein (in grammes) recommended by different authorities for an average man weighing about 150 lbs., and engaged in ordinary activities.

Molechott	... 130	grammes
Rubner	... 127	do.
Atwater	... 125	do.
Wolff	... 125	do.
Playfair	... 119	do.
Voit	... 118	do.
Munk	... 105	do.
Hutchinson	... 100-120	do.
McLester	... 100-120	do.
Halliburton	... 100-120	do.
Lusk	... 100 (?)	
McCarrison	... 90-100	do.
Chittenden	... 50	do.
Hindhede	Below 40	do.

(2) The habits of people all over the world in regard to the consumption of protein-food go against the findings of Chittenden.

(3) As Chittenden's experiments were confined among a small number of people for a limited period only, it would not be safe to draw any broad and general conclusion from them.

(4) The poor physical condition of some of the races living in India, who habitually consume less than three ounces of protein per day (but more than what Chittenden considers to be the proper quantity) would go to negative his theory.

(5) Lastly, one must have sufficient protein in one's daily diet not only to fully meet the requirements of the system but also to act as "reserve energy," in order to keep the body always fit and maintain at par its power of resistance against infection of any kind.

We are, accordingly, of opinion that the safest course is to accept the conclusion of the majority of physiologists and fix 90 grammes (3 ounces) of *water-free* protein, as the minimum daily requirement for a healthy adult person.

Fats and carbo-hydrates act as fuels and are interchangeable to some extent. In a normal healthy diet, both should, however, be present in adequate proportions. Carbo-hydrates are more easily burnt in the system than fats and are, therefore, more simple and convenient sources of heat and energy than fats. Weight per weight, fat yields more than

double the energy given by carbo-hydrates, but being deficient in Oxygen, it does not readily burn like carbo-hydrates in the system. The association of carbo-hydrates with fats in our diet materially helps its combustion. People living in cold regions of the earth require more fat than those living in tropical regions. There are races in the world, such as the Esquimos, who ordinarily cannot procure any carbo-hydrate food and, accordingly, they draw all heat and energy from protein and fat of their animal diet. In a well-balanced diet, however, proteins, fats and carbo-hydrates, each and all, should find their place in proper proportions. In a hot country like India, about 2 ounces of *water-free* fat and 16 ounces of *water-free* carbo-hydrates should constitute the minimum daily ration of an adult healthy person. To this, about an ounce of salts of the various elements entering into the composition of the human body should be added, and about 3 pints of water, over and above that contained in our food-stuffs, should be drunk in 24 hours to make up for its loss through various discharges from the body.

We have spoken of the nutrients as *water-free*, but they cannot be had in this condition in nature. All our food-stuffs contain more or less water. For example, milk contains about 88 per cent. of water, meat about 70, fish 75, eggs 74, rice 11, wheat 15, butter 10, potato 74 and green vegetables from 90 to 95 per cent. On an average, our food-stuffs contain about 50 per cent. of water, so that by doubling the minimum daily allowances of *water-free* nutri-

ents, we can roughly estimate the quantity of food an adult person should take in 24 hours in the form in which it is presented to us by nature. Thus we find that the total quantity of food to be consumed by a healthy adult person in 24 hours should be as shown below :—

Protein-food	...	6 Ounces
Fats	...	4 ,,
Carbo-hydrates	...	32 ,,
Salts	...	1 Ounce
Total	...	43 Ounces or about 1⅓ *seers.*

For every additional pound to the average weight of the human body, 1/40 ounce of protein-food should be added in the shape of meat, fish, *dal* or fresh milk-curd (*chhana*).

Milk is the only food-stuff in which the different nutritive principles are present in suitable proportions to meet the physiological requirements of a child, but, for various reasons, milk alone is not suitable for adults. We must, therefore, have to draw the required quantities of nutrients from other food-stuffs as well. None of these, however, contains both nitrogen and carbon in the proportions which would satisfy the needs of the body. For instance, if we take two pounds of meat, we can obtain the required amount of nitrogen (300 grains) but not more than 1,800 grains of carbon in place of 4,500 grains which we daily require to replace the loss of carbon from the body. Again, by taking 1½ lbs. of rice, we can secure 4,500 grains of carbon but not more than 78 grains (in place of 300 grains) of nitrogen. We thus see that neither of these two food-stuffs taken alone can make up the daily loss of

these two elements from our system. This holds true in the case of most other kinds of food-stuffs. Therefore, we must have to use different kinds of food-stuffs in such quantities as to yield nitrogen and carbon in the required proportions.

To find this out, we must, first of all, have knowledge of the exact proportions in which the several nutritive principles are present in the different food-stuffs used by us. These have been ascertained for us by careful laboratory experiments, determining the percentage of protein, fat, carbo-hydrates, salts and water present in different food-stuffs. It has also been ascertained by actual laboratory experiments how much energy is evolved by a weighed quantity (say 1 gramme) of protein, fat and carbo-hydrates respectively (*e.g.*, by means of the Bomb-calorimeter). Having these data at our command, we can easily find out, by a simple process of calculation, the number of grammes of protein, fat and carbo-hydrates as well as the amount of energy, expressed in calories, which an ounce of the different food-stuffs would supply. It is easy then for us to calculate the exact weights of the different food-stuffs we should use daily in order to obtain the various nutritive principles in required quantity and also the required amount of energy.

Table VI gives the percentage composition of some of the common food-stuffs in daily use and the quantities (in grammes) of the three important nutritive principles and the calories which an ounce of each would supply.

TABLE VI.

(1 oz. = about 30 grammes = ½ *chittak.*)

FOOD STUFFS.	PROTEIN.		FAT.		CARBO-HYDRATES.		Salts per cent.	Water per cent.	Calories available per oz.
	Per cent.	Grms. available per oz.	Per cent.	Grms. available per oz.	Per cent.	Grms. available per oz.			
Rice (average) ...	5·0	1·42	0·8	0·23	83·2	23·6	0·5	10·0	102·1
Muri ...	6·3	2·1	1·2	0·3	68·3	19·4	3·3(?)	6·3	88·7
Khai ...	6·9	1·9	2·4	0·7	73·0	20·7	1·3	6·4	96·7
Pulses (*dál*, average) ...	23·5	6·7	2·29	0·65	55·9	15·9	7·1	11·3	96·25
Wheat ...	14·6	3·9	1·2	0·54	67·9	20·35	1·6	14·0	102·0
White flour ...	11·0	3·1	2·0	0·3	71·2	19·2	0·8	15·0	91·9
Atta (wholemeal)	11·5	3·3	2·9	0·8	67·1	19·0	3·85	14·65	96·4
Sooji (semolina)	14·38	4·0	2·28	0·6	47·42	13·5	0·51	10·52	75·8
Barley ...	12·7	2·97	2·0	0·62	71·0	20·60	3·0	11·3	100·0
Maize ...	10·0	2·13	6·7	0·48	64·5	20·80	1·4	13·5	96·0
Oatmeal ...	12·6	3·6	5·6	1·6	63·0	17·9	3·9	15·5	10[illegible]·4
Arrowroot ...	0·8	0·23	0	0	83·3	23·6	·27	15·4	95·3
Bread ...	8·0	2·6	1·5	0·36	49·2	14·9	1·3	40·0	74·9
*Roti (chapatee)	9·43	2·82	3·71	1·11	69·20	20·76	·33	17·33	107·0
Biscuits ...	15·6	4·4	1·3	0·4	73·4	20·8	1·7	8·9	104·0
Milk (cow's) ...	3·97	1·1	4·4	1·2	4·5	1·3	0·73	86·4	20·0
Milk (Buffalo's)	4·52	1·2	8·2	2·5	4·6	1·4	0·88	81·8	25·0
Milk (goat's) ...	3·62	1·21	4·2	1·13	4·0	1·21	0·56	87·54	20·0
Milk (Ass) ...	1·79	0·53	1·02	0·3	5·5	1·7	0·42	90·17	12·0
Human milk ...	2·97	0·87	2·90	0·86	5·87	1·76	0·16	88·0	18·0
Milk (condensed)	9·68	2·49	8·90	2·35	54·53	15·31	1·95	24·94	92·0
Butter ...	1·5	0·3	90·5	23·10	0	0	1·0	7·5	208·0
Ghee ...	0	0	100·0	29·1	0	0	0	0	278·0
Chhana (curd) ...	21·63	6·3	16·8	5·3	0·28	0·1	1·68	58·72	73·0
Dahi (curdled milk) ...	4·77	1·40	3·57	1·0	2·8	0·80	0·62	87·84	18·0
Cheese ...	31·0	7·4	28·5	9·2	0	0	4·5	36·0	119·1
Cream ...	2·7	0·81	27·7	8·3	2·8	0·9	1·8	66·0	92·6
Ghol (butter-milk) ...	3·93	0·85	0·5	0·14	4·8	1·36	0	0	10·0
Potatoes ...	2·0	0·5	0·16	0·05	21·0	5·8	1·0	74·0	27·0
Tomatoes † ...	0·8	0·20	0·49	0·10	3·6	1·27	——	94·73	6·0

* Some amount of *ghee* is always added to wheat-flour to make *rotees* or *chapatees*.

† The percentage of fat in these appears to be too high; probably it includes other matters, such as pectose, mucilage, etc.

TABLE VI—(*contd.*)

FOOD-STUFFS.	PROTEIN.		FAT.		CARBO-HYDRATES.		Salt per cent.	Water per cent.	Calories available per oz.
	Per cent.	Grms. available per oz.	Per cent.	Grms. available per oz.	Per cent.	Grms. available per oz.			
Cabbages ...	1·8	0·60	0·05	0·03	5·8	1·27	0·7	91·0	7·0
Cauliflower ...	0·5	0·15	0	0·01	2·0	0·66	0·7	92·0	9·0
Patol ...	0·75	0·21	0·36	0·12	3·86	1·2	0·84	90·64	7·0
Brinjal * ...	0·89	0·34	1·48	0·09	3·48	1·44	1·38	93·65	8·0
Olkapi (knol-kohl)	0·84	0·26	0·54	0·16	11·4	3·3	1·16	87·0	16·0
Moola ...	0·21	0·07	0·06	0·02	3·38	0·96	0·64	95·7	5·0
Denros (lady's finger) * ...	1·91	0·57	1·11	0·33	5·72	1·7	0·8	90·40	12·0
Bilati kumra *...	0·90	0·28	1·03	0·32	3·93	1·1	0·7	93·4	8·32
Barbati * ...	3·5	1·02	1·25	0·39	1·75	0·56	1·6	91·9	14·5
Onions ...	1·57	0·5	0	0	2·5	0·81	0·45	88·9	5·51
Palong sak ...	1·6	0·51	0·20	0·06	0·5	0·14	2·4	92·0	3·12
Lettuce * ...	1·31	0·41	1·32	0·42	1·40	0·44	0·6	95·36	7·0
Jack-fruit seeds	13·4	0·42	1·98	0·64	31·2	10·2	2·27	46·46	47·0
Beet * ...	1·96	0·65	2·91	0·95	11·41	3·6	1·3	83·3	25·5
Mankachu * ...	1·82	0·58	1·60	0·51	11·95	3·7	1·46	81·24	21·0
Green plantains *	1·31	0·41	2·7	0·88	16·82	5·4	0·17	79·0	30·5
Green peas ...	6·35	1·8	0·53	0·15	12·0	3·4	0·81	78·4	22·0
Soya beans ...	34·82	9·6	16·8	4·7	34·0	9·5	——	——	119·0
Unripe jack-fruit (*Ichar*) ...	8·52	2·4	0·94	0·27	16·28	5·2	1·95	63·41	31·5
Green vegetables (average) ...	2·05	0·60	0·34	0·1	5·33	1·4	——	——	8·9
Plantains ...	1·5	0·5	...	0·03	17·78	2·19	0·78	73·32	11·0
Apples ...	0·39	0·11	...	0·06	7·73	3·2	0·31	83·5	15·0
Pears ...	0·36	0·09	...	0·03	8·26	2·29	0·31	83·0	10·0
Peach ...	0·65	0·1	...	0·03	4·48	2·66	0·69	80·03	12·0
Grapes ...	0·59	0·16	...	0·03	24·36	6·8	0·53	74·52	27·8
Mangoes ...	1·2	0·34	0·76	0·21	17·58	4·99	1·2	75·5	23·2
Jack-fruit (ripe)	1·16	0·29	0·43	0·1	18·58	4·65	0·96	80·82	20·6
Oranges ...	0·44	0·15	0·27	0·07	6·62	2·0	0·6	88·25	9·2
Guavas ...	1·5	0·37	0·8	0·20	9·0	2·27	0·66	80·04	12·0
Papaya ...	0·57	0·16	...	...	0·35	0·10	...	...	1·0
Lichis ...	3·0	0·84	0·25	0·07	6·8	1·9	...	...	12·0
Anaras (pine-apple) ...	0·46	0·17	0·20	0·05	8·13	2·1	1·68	90·26	9·0

* The percentage of fat in these appears to be too high; probably it includes other matters, such as pectose, mucilage, etc.

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TABLE VI—(*concld.*)

FOOD-STUFFS.	PROTEIN. Per cent.	PROTEIN. Grms. available per oz.	FAT. Per cent.	FAT. Grms. available per oz.	CARBO-HYDRATES. Per cent.	CARBO-HYDRATES. Grms. available per oz.	Salts per cent.	Water per cent.	Calories available per oz.
Cocoanut kernel	5·94	1·7	53·14	15·1	5·46	1·5	1·39	19·03	148·7
Cocoanut water (fresh) ...	1·41	0·4	0·40	0·1	2·39	0·7	0·63	95·52	3·4
Ground-nuts ...	26·13	6·8	43·81	13·4	13·68	2·3	1·58	26·13	157·0
Almonds ...	24·2	6·7	53·7	15·2	7·2	2·9	2·9	5·4	176·9
Walnut ...	15·6	4·8	62·6	19·0	7·4	4·8	2·0	4·6	208·0
Raisins ...	2·8	0·73	3·6	0·93	44·2	11·6	...	...	99·8
Dates ...	1·5	0·3	0·87	0·25	56·7	16·2	...	...	68·0
Eggs (duck) ...	13·3	3·8	14·5	4·1	0	0	1·3	70·5	52·1
Eggs (hen) ...	13·5	3·8	11·6	3·3	0	0	1·0	73·5	44·9
Rohi ...	18·35	4·9	9·56	2·1	0	0	1·42	74·60	39·5
Koi ...	17·73	5·0	0·42	0·12	0	0	1·06	81·83	21·4
Magoor ...	19·49	5·5	0·5	0·14	0	0	1·3	78·85	22·8
Bhetki ...	16·26	4·6	4·12	1·2	0	0	0·84	77·29	30·0
Hilsa ...	14·85	4·2	9·23	2·6	0	0	0·95	76·33	40·2
Topsa (mango fish) ...	16·76	4·7	4·12	1·2	0	0	0·83	77·82	30·4
Lobster (fleshy portion) ...	15·45	4·4	0·48	0·14	0	0	0·90	83·05	19·3
Beef ...	20·5	5·8	3·5	·99	0	0	1·6	74·4	27·0
Pork ...	9·8	2·8	48·9	13·9	0	0	2·3	39·0	140·7
Goat's flesh ...	24·96	6·8	2·5	0·7	0	0	1·2	...	34·4
Mutton ...	16·0	3·8	16·0	3·8	0	0	1·0	52·0	49·4
Fowl ...	23·3	6·1	3·1	0·7	0	0	1·0	70·0	31·0
Duck ...	20·7	5·8	10·5	2·94	0	0	...	...	50·0
Venison ...	19·7	5·8	1·9	0·6	0	0	1·1	75·7	28·6
Sugar ...	0	0	0	0	96·5	28·1	0·5	3·0	115·2
Goor ...	0·28	0·08	0	0	89·2	26·0	...	...	107·0
Molasses ...	0	0	0	0	69·7	20·4	3·4	23·4	83·6
Madhu (honey)...	0·4	0·11	0	0	72·18	20·21	...	...	81·0
Sandesh (best)...	18·17	6·0	19·75	5·7	40·18	11·6	1·65	20·25	112·9
Jam ...	0·21	0·06	...	...	71·7	19·81	...	...	79·0
Marmalade ...	0·21	0·06	...	...	71·6	19·41	...	...	78·0
Cocoa ...	14·0	4·6	48·0	14·0	18·0	5·2	5·0	5·5	165·2
Mustard oil ...	0	0	98·0	28·0	0	0	0	0	252·0
Cocoanut oil ...	0	0	98·0	28·0	0	0	0	0	252·0
Cocogen ...	0	0	98·0	28·0	0	0	0	0	252·0
Ground-nut oil ...	0	0	98·0	28·0	0	0	0	0	252·0
Olive oil ..	0	0	98·0	28·0	0	0	0	0	252·0

We have now got nearly all the necessary data for the construction of a suitable dietary. Besides

these, we have to take note of certain factors other than the mere physiological needs of the body into our consideration. Thus, a dietary may be quite good from the physiological point of view, but it may not be found suitable on economic grounds. Again, the habits of the individual, his idiosyncracies, his religious convictions, his social customs and even prejudices, the law of demand and supply —all these have their bearing on the consideration of this question, as well for an individual as for the community at large. We shall confine ourselves here to the construction of a dietary for a healthy young Indian adult, engaged in ordinary pursuits of life and doing a moderate amount of exercise.

Taking all the above factors into our consideration, and keeping in view the minimum daily requirements of the different nutrients previously discussed, we give a table below (VII showing the quantities of the different raw food-stuffs that would be required by a young healthy Indian adult in 24 hours. This will give him about 90 grammes of protein, from 60 to 70 grammes of fat, about 475 grammes of carbo-hydrates, about an ounce of salts and about 2,854 calories. He can prepare a variety of dishes out of these materials according to his taste and habits and take them in the course of the two large meals in the morning and evening and one or two small meals at intervals. It will be seen at once that there is a good admixture of both animal and vegetable proteins in this dietary. For those who are pure vegetarians, fish or meat may easily be substituted by milk, or by *dahi* and *chhana* (fresh milk-curd). Those who drink tea

should add from 3 to 4 ounces of milk to this diet. The total cost would not exceed As. 8 per day, and incidentally, it may be observed here that in these days of high prices, a healthy nourishing Indian diet cannot be obtained at a less cost. Parents and guardians and the authorities of hostels and messes should remember this fact and see that a little more money is spent on the head of diet of our young men. The money thus spent will be a profitable investment in the long run.

TABLE VII.

Food-stuffs.	Quantity in ounces.	Protein in grammes.	Fat in grammes.	Carbo-hydrate in grammes.	Calories.
Rice ...	6	12·5	0·72	138	574
Atta (wheat-flour) * ...	10	36	8·7	201	1,000
Dal (Pulses) ...	3	18	2·4	46	276
Fish † ...	5	20	11·0	0	278
Potato ...	6	0·5	3·0	36	150
Other vegetables ‡ ...	8	3·0	...	20	80
Ghee ...	½	...	14·5	...	135
Mustard oil ...	1	...	29·0	...	252
Sugar § ...	1	...	...	27·3	109
Salt ...	1	...	...	...	...
Spices ...	As necessary.				
TOTAL ...	41½	90·0	69·32	468·3	2,854

* As *atta* (wheat-flour) contains nearly twice the amount of protein as that contained in rice, it should replace rice in one of the chief meals of the Bengalis. If it is found impossible to do so in any case, the same quantity of rice should be allowed.

† For vegetarians and also for the purpose of introducing variety in the ordinary diet, say, for two or three days in the week, fish may be replaced by 4 ounces of *chhana* (fresh milk-curd) and 4 ounces of *dahi*, or by half a *seer* (one pint) of milk. Fish may also be replaced by an equal quantity of meat or by two eggs, twice a week, if so desired.

‡ Green leafy vegetable should form a good portion on this head.

§ A part of *atta* may be replaced by *sooji*, and *halooa*, made of it with sugar and *ghee*, may form a good tiffin.

Generally speaking, the people of India are fond of milk and milk-products, there being many who cannot do without it. Now-a-days, milk is considered to be a very important article of food by most physiologists in Europe and America and arrangements are being made for an increased supply of pure milk in those countries. For those Indians who cannot do without milk, the following dietary will be found suitable, its nourishing and energy value being practically the same as that shown in the previous table :—

TABLE VIII.

Food-stuffs.	Daily Quantity in Ounces.
Rice	6
Atta	10
Dal	2
Fish or Meat	5
Potatoes	4
Other vegetables ...	4
Ghee	0·75
Oil	0·75
Milk	20·0
Salts	1·0

Some of the modifications suggested in the note annexed to the previous table apply to the present case also.

McCarrison, in his little book on "*Food*" has given the following table showing the kind and quantity of food taken by certain races of Northern India which keep them healthy and fit :—

TABLE IX.

Food-stuffs.	Amount in Ounces.
Atta	12
Rice (home-pounded) ...	6
Dal	1
Meat (mutton)	2
Milk	20
Vegetable oil	1
Ghee	1·5
Root vegetables	8
Cabbage	8
Mango	4

The above dietary would yield about 95 grammes of protein and 2,900 calories.

Hutchinson lays down the following dietary for a healthy young adult Englishman (weighing about 150 lbs.) in ordinary activity and taking a moderate amount of exercise :—

TABLE X.

Food-stuffs.	Daily Quantity in Ounces.
Bread	16
Meat	8
Butter	4
Potato	16
Milk	10
Eggs (2)	4
Cheese	2

The above dietary would yield about 120 grammes of protein.

With the above, some green leafy vegetables like salads, vinegar, common salt and condiments (mustard, pepper, etc.) are to be taken.

Adjuncts to food.—We shall now consider certain substances which are invariably used all over the world as *adjuncts to food*. These consist of condiments, vinegar, pickles and *chutneys*, tea, coffee and cocoa. A sparing use of any of these articles

would produce no harm to the system; on the other hand, used in moderation, they promote appetite and cause increased secretion of the digestive juices, thus helping the function of digestion indirectly. Certain of the spices used in the preparation of our foods act as carminatives also, besides making the dishes more agreeable to the palate. The fault, however, in the preparation of some of the Indian dishes is that they are too highly spiced and, accordingly, are harmful to the digestive organs. Excessive use of such condiments as mustard, pepper, ginger, cardamoms, cinnamon, cloves, saffron, etc., must be avoided and chillies should be very sparingly used. *Chutneys*, made of green mangoes, limes, tamarind, green plums, *amra*, and other acid vegetable fruits, promote appetite, increase the alkalinity of the blood and prevent the incidence of scurvy.

Tea and coffee possess no food value but act as stimulants only. Their active principles are *theine* and *caffeine* respectively. They are not necessary for the maintenance of our health. They are pleasant and agreeable drinks when taken in moderation, but their excessive use leads to indigestion, sleeplessness, nervous irritability and palpitation of the heart. Cocoa contains a large percentage of protein and fat and it, therefore, acts both as a food and as a mild stimulant. But its value as a food in the quantity in which it is taken is not appreciable. Its active principle is *theobromine* which is a milder stimulant than either *theine* or *caffeine*.

Drink.—The best drink is water. We require, on an average, from 3 to 4 pints of water daily to replace the loss from the body. It helps to flush the

system, getting rid of the waste-products of the body through the various eliminatory channels. Too large a draught of water immediately after meals should be avoided, as also iced drinks.

Alcohol as a drink is most harmful even in moderate doses. It has no food-value as was believed at one time. It first acts as a stimulant, and then depresses the system. Its value is medicinal and should not be used except under medical advice. It has no place in the dietary of a healthy person. Even prolonged use of alcohol in moderation produces degenerative changes in the digestive and other vital organs of the body and leads to chronic dyspepsia and other serious troubles.

Aerated waters are good when used in moderation.

Water of green cocoanut is largely used as a drink in many parts of India. It is a refreshing and cooling drink and as it contains both protein and fat, it is largely used both as a drink and food in fever cases. It causes a larger flow of urine and checks vomiting.

Ghol (butter-milk) is largely used as a cooling drink in health as well as in sickness. It is a very refreshing drink and is food also in fever cases and in some forms of bowel complaints.

Sherbets are cooling drinks made of sugar-candy or of fruit-juices and sugar, and are largely used, iced, in the hot weather throughout India. Artificial fruit syrups are generally made of essential oils, *invert* sugar, saccharine and water. These possess little food-value and should better be avoided.

Acid-forming and base-forming diets.—There are several food-stuffs which, when digested, go to increase the acidity of the blood and there are other kinds which increase its alkalinity. The first are called "*acid-forming*" foods, the second, "*base-forming*." Human blood is by nature alkaline in character. When acids form in the body, the acidity of the blood increases, which is not conducive to the preservation of health, for it helps the incidence of certain diseases in the body. For example, in certain diseases of the kidney, such as *Nephritis*, the increase of acidity is a source of considerable mischief. On the other hand, in cases of high blood-pressure, base-forming foods give considerable relief. In Table XI, a list is given of the *acid-forming* and *base-forming* foods. Generally, it may be said that fish, meat, eggs, rice, *dal* and flour increase acidity, while milk, fruits and vegetables help the formation of alkalinity in the system. Thus we see that both in the case of a meat diet consisting of meat, fish and eggs, and in a vegetarian diet consisting largely of rice or bread and *dal*, it is necessary to take an adequate quantity of fruits and vegetables, for, otherwise, the blood will get more acid in character rendering it possible for certain serious maladies to attack the system.

TABLE XI.

Acid-forming food.	Base-forming food.
Meat	Milk
Fish	Apples
Eggs	Plantains
Oatmeal	Oranges
Rice	Lemon
Indian and English bread	Nuts
Dal	Raisins
Ground-nut	Cabbages
	Cauliflower
	Lettuce
	Beet-root
	Moola (radish)
	Carrot
	Celery
	Peas
	Kidney beans (*sim*)

Among the *base-forming* food-stuffs, apples, plantains, oranges and potatoes are the best for neutralising the acidity in the system.

CHAPTER VII.

A Brief Survey of Some of the Common Food-Stuffs.

Milk.—The first place for consideration should be given to milk, because it is the only food which contains all the nutritive principles in proper proportions and is designed by nature for the support of young children. There are, however, several objections to the use of milk as the sole food for a grown-up person. The composition of milk is practically the same in all animals, though the proportion of the nutritive principles varies.

While milk and its various products form a very important constituent in the dietary of all nations, they are indispensable in the case of Indians. What meat is to Europeans, milk is to Indians. A large proportion of the people of India do not touch meat, fish or eggs; accordingly, the principal source of protein and fat in their daily diet must be found in milk or one or other of its products. Owing to its dearness and the difficulty in obtaining milk of good quality, the present-day diet of Indians of small means suffers in its nutritive value and thus has a baneful influence on their physique and physical qualities.

Two kinds of milk are in use in India—cow's milk and buffalo's milk. The specific gravity of good cow's milk should not be below 1028, and the

percentages of fat and non-fatty solids should not be lower than 3·5 and 8·5 respectively. The figures for the buffalo milk should be 6 and 9 respectively. Buffalo milk is thus twice as rich in fat as cow's milk and is unsuitable for young children unless largely diluted with water.

The chief adulterant of milk is water. Sometimes, dirty water is used for this purpose, and such milk often becomes the carrier of infectious diseases such as cholera, typhoid fever, etc. The extremely insanitary condition in which cows are generally kept and milk is drawn and sold in this country, is another potent source of infection of milk. Milk drawn from cows suffering from tuberculosis, when used unboiled, has been known to produce that disease in children. The only way to make milk a *safe* food, specially in India, *is to boil it before use*. Boiling, no doubt, destroys some of the vitamins present in milk, but it is the lesser of the two evils. As food for infants, cow's milk is much inferior to human milk. It should be well diluted with water and mixed with a little cream and milk-sugar before being used as infant-food. The protein of milk possesses the same nutritive value as the protein of meat, and is greatly superior to that obtained from grains and other vegetable foods. Milk, when added to a vegetarian diet, greatly enhances its nutritive value. McCallum attributes the superior physical development and the greater stamina of pastoral people to their freer use of milk and milk-products. McLester has called attention to the wonderful physique and the courage of the Arabs whose diet

consists in a large measure of milk and milk-products obtained from their flocks and he is of opinion that physical beauty, high mental qualities and longevity are very much in evidence among people who own flocks and are in the habit of consuming milk. From the economic point of view, milk has also to be recommended, as, for the value we pay, we get more nourishment from it than from meat, fish or eggs.

(1) *Butter*.—Among the various products of milk, we may mention butter as the most important of all. Good butter should contain about 90 per cent. of fat and 10 per cent. of water. It is the most easily digestible form of fat and contains considerable quantities of vitamins (A and D). Butter is manufactured in India both from cow's milk and buffalo milk. Butter from cow's milk is prized more highly and is more costly. Indians do not use butter so much as *ghee* which is made from it. The fuel-value of both butter and *ghee* is higher than that of any other food. Butter contains more vitamins than *ghee*.

(2) *Dahi*.—It is a milk-product obtained by lactic acid fermentation of milk. The milk-sugar only undergoes changes forming lactic acid which curdles the milk, the other nutritive elements remaining unaltered. When warm milk is treated with *dahi*-ferment and allowed to stand quietly for about 24 hours, it gets curdled and solidified, and *dahi* is formed. Many people prefer *dahi* to milk, as it is found more easily digestible. *Dahi* made

with a special ferment possesses the property of destroying putrefactive organisms inhabiting the intestinal tract. These organisms, according to Metchnikoff, hasten decay and bring on premature old age. *Dahi* made into *ghol* is used as a refreshing drink during the hot months of the year.

(3) *Chhana* (Fresh milk-curd).—On the addition of an acid (such as lime-juice) or rennet to milk, coagulation takes place and its solid constituent known as casein is precipitated along with a portion of fat. This, when filtered, forms the milk-curd (*chhana*) which is one of the best forms of proteins known. It is even superior to the proteins of meat and fish, as it contains no *purin bodies* from which the latter are not free. It should enter largely into the diet of the Indians who live chiefly on vegetable foods. It is also an economical food, for there is nothing to be rejected in the shape of refuse, as is the case with meat and fish. Sweetmeats made of *chhana* are largely used by well-to-do Indians. The two most frequently used are *sandesh* and *rasagolla*, and the first is the best of all Indian sweets both from view-points of nutrition and digestion. Best *sandesh* contains about 23 per cent. of protein and 18 per cent. of fat. It would much improve the dietary of Indian students if 4 ounces of *chhana* are added to their daily food, the average cost of which is about one anna only.

(4) *Cheese*.—It is obtained by adding rennet to milk and subjecting the solid curd to a kind of fermentation, pressure and process of drying. It is

a highly nutritious food very seldom used by Indians but extensively by Europeans. It contains more protein than meat, fish and *dal* and is also rich in fat. Sometimes a poison (called Tyrotoxicon) is produced in cheese and gives rise to symptoms of cholera. It is not an easily digestible article.

(5) *Ghee.*—It is obtained by heating butter to a moderately high temperature and straining the melted stuff. It is considered to be an indispensable article of diet in all Indian households and rightly so. It is the most easily digestible of all fats and contains a good quantity of vitamins (though less than butter). It is the best of all strength-giving foods. Good *ghee* should be whitish or yellowish and granular in appearance, with an agreeable odour. No article of food is so much adulterated in India as *ghee*. All kinds of animal fats and vegetable oils, edible or inedible, are used as adulterants of *ghee*. What is sold in the market as "vegetable *ghee*" or "*Banaspati ghee*" contains no *ghee* at all; it is manufactured either from vegetable oils or animal fats and it contains no vitamins. *Ghee* is largely used for the preparation of Indian food of all kinds. Well-to-do Indians use it freely with rice and also with wheat-flour to make *loochis*, *parotas*, *chapaties* and cakes of other kinds.

(6) *Condensed milk.*—It is milk thickened by being heated in vacuum with or without the addition of sugar. Some of the varieties are deficient in fat and they generally lack in vitamins. They may be used where fresh milk is not available.

Meat.—The next important item of food for our consideration should be meat which is the chief protein-food of man all over the world. The protein of meat is easily digested and is readily assimilable. Butcher's meat (*e.g.*, beef, mutton, pork, goat's flesh, etc.) also called *red* meat, is less easily digestible than *white* meat which belongs to the domestic fowl. A too liberal use of meat in the tropical climate should be avoided as far as possible. One should take great care in the selection of meat, as it often harbours dangerous parasites and microbes. Flesh of diseased animals (suffering from tuberculosis, anthrax, rinderpest, etc.,) should be rejected. Different species of tapeworm and other parasites are known to infest pork and beef; such meat, when consumed, produces the corresponding disease in man. A thorough inspection of the animals before slaughter and of carcass and meat before sale should be made by the officers of the Health Department and diseased meat should be destroyed at once. Meat should be well-cooked, as otherwise, the parasites and microbes present in it, are not killed. Sometimes, poisons of an alkaloidal nature, called *ptomaines*, are developed in meat in which decomposition has set in. This poison is not destroyed by cooking. The consumption of such meat gives rise to severe gastro-intestinal disorders, often attended with fatal results.

Meat extracts, soups, etc., contain little nourishment. They act as stimulants only.

Fish.—We shall next consider fish which ranks next to meat as a nourishing animal food. It is

less stimulating but more easily digestible than meat. For the rice-eating people of Bengal, fish constitutes a very valuable protein-giving food. The best fish in Bengal is *rohi* which contains about 18 per cent. of protein and about 8 per cent. of fat. *Hilsa* generally contains a larger quantity of fat and is, therefore, somewhat difficult to digest. *Koi*, *magoor* and *singee* contain less than 1 per cent. of fat and are, therefore, largely used as food for invalids. Fish is not an economical food; the wastage in bones, scales, etc., is about 50 per cent.

Lobsters and crabs belong to the Crustacea and are difficult to digest. Their consumption is sometimes followed by wheal-like eruptions.

Fish generally does not carry infection except a few tribes. It rapidly undergoes decomposition. Putrid fish is poisonous. Salted and dried fish are less nutritious than fresh fish. Tinned fish sometimes gives rise to symptoms of poisoning.

Fish oil is full of vitamins, codliver oil being the best of the lot. Fish-roe also contains a good quantity of vitamins.

Egg.—Next to milk, egg is another *complete* food. It is full of protein, fat and vitamins. Very valuable salts of phosphorus and iron are present in the yellow part (yolk) of egg. In a rice-diet, a liberal use of eggs would make up its deficiency in protein and fat. It should enter largely into the dietary of our young men. Duck's eggs are as good as hen's eggs, and being of larger size, contain more nourishment. Eggs should be eaten half-boiled;

hard-boiled eggs are not so easily digestible as soft-boiled or raw eggs. Eggs are said to be free from *purin bodies*, and the popular belief that consumption of eggs gives rise to gouty or rheumatic troubles does not find support in experience.

Eggs showing any sign of decomposition should be rejected.

Rice.—Among the cereals, rice is the staple food of the Bengalis, the Orias, the Madrasis and a few other races of India. The *atap* (sun-dried) rice is considered to be more nourishing than the parboiled variety (*siddha* rice). It is the poorest of all cereals in regard to its protein-contents and is also very deficient in fat and salts. White polished rice contains no vitamins; prolonged use of such rice gives rise to polyneuritis in birds and *beri-beri* in man. Its use should always be avoided. Rice-water should not be thrown away; the cooking should be done in such a way that it may be eaten along with the rice, for it contains some part of the protein, salts and vitamin present in the rice. A dish prepared by boiling together rice, *dal*, *ghee* and some vegetables such as potatoes, green peas and cauliflower, forms an excellent nourishing food called *khichuri* which should be more largely used in Indian homes.

Rice is a valuable economical food on account of its energy-value, and its starch is very easily digestible.

As rice is poor in protein, the diet of the people of Bengal would greatly be improved by substituting

wheat-flour for rice in one of the daily meals. This is particularly applicable to young people in the growing period of life.

Rice is very deficient in lime salts, so necessary for the bones of the body. *Dal* and green leafy vegetables, taken along with rice, would supply the deficiency.

Where rice forms the chief part of the diet, it should be supplemented by the use of *dal*, green leafy vegetables, milk or milk-products, fruits and nuts to make up its deficiency in protein, fat, salts and vitamins.

Muri (puffed rice), *khoi* (fried paddy) and *chira* (beaten rice) are some of the preparations of rice largely used in Bengal for lighter meals in the morning and evening by all classes of people. They are generally taken with fried grams, cocoanut kernel and *goor* and the combination is excellent, both from points of view of economy and nutrition. This is far superior to *bazar* sweets which are prepared with *ghee* and mustard oil of very inferior quality.

Various kinds of cakes and puddings are made from rice which are agreeable to the palate and easily digestible.

Wheat.—Next to rice, we shall consider wheat which is the staple article of diet of the people of the U.P., the Punjab and some other provinces of India, and as it contains a larger amount of protein than rice and as it is generally taken along with a liberal allowance of *dal*, the races living in these

parts are of much better physique and possess finer physical qualities than the people living on rice alone. Wholemeal flour contains more proteins and vitamins than white flour and should, therefore, always have preference. Flour is made into English bread or into *chapatees* and *pooris*. *Chapatees* (unleavened bread) contains more protein and less water than English bread (*paoroti*), but they are generally underbaked and these are not so easily digestible as English bread. English bread, raised either by the use of yeast or baking powder, is light and spongy and readily acted upon by the digestive juices. *Chapatees*, when properly baked, are excellent articles of food and are highly appreciated even by foreign anthorities. Kellog says of them :—

"The sweetest and most wholesome bread is that made from the whole meal of the grain (wheat) mixed with water, with perhaps the addition of a little salt and baked in thin cakes or small loaves. Bread is made in this way by tribes of northern India."

English bread should not be eaten hot. It should be allowed to stand for some length of time before being eaten.

The bran of wheat contains a good quantity of salts and vitamins. Those who take white bread should take half an ounce of bran daily with other food. This will supply the body with the necessary mineral elements and "help to check decay of teeth and injury to other bone structures."

Prof. Grierson's experiments show that the starch of rice, wheat and Indian Corn requires 2 hours for digestion, starch of oatmeal 80 minutes, arrowroot 30 minutes, and potato starch is completely digested in 10 minutes.

Sooji (semolina) is obtained from wheat. It contains more protein and less starch than flour. It is largely used as an invalid food and also for the preparation of many kinds of sweetmeats and puddings.

Oatmeal.—It is rich in protein and fat and is the richest of all cereals in its iron-contents. It also contains a good quantity of lime. With milk, it forms a highly nutritious dish.

Dal (Pulses).—We shall now consider some of the various kinds of *dals* in use in India. They are rich in proteins and supply the place of meat in the Indian dietary. *Dal* is an economical food. Besides protein, it contains a considerable quantity of starch, salts and vitamin B. It makes up the deficiency of protein and salts in a rice-diet. It is generally deficient in fat; *ghee* or oil is, therefore, always added in the preparation of *dal*. *Dal* could be cooked and may always be taken in adequate quantity without causing monotony in the diet. The protein of *dal* is of inferior biological value to that contained in meat, fish or milk; in a vegetarian diet, therefore, *dal* should always be supplemented by milk and milk-products. Bengalis are afraid of

taking the necessary amount of *dal* for fear of causing indigestion. When properly cooked, *dal* is not difficult to digest and a very large percentage of protein in it (about 92 per cent.) is utilised in the system, the figures for meat and milk being 97. Among the various kinds of *dal*, *moong dal* is more easily digestible than any other variety and is largely used in this country as an invalid food. *Mosoor* (lentil) contains the largest percentage of protein and Europeans make soup out of it. *Chhola* (gram) contains the largest quantity of fat that is to be found in any variety of *dal* and is highly appreciated as a nourishing food. *Khesari*, when continuously used for a long time, is said to produce a kind of paralysis of the lower extremities called *lathyrism*. *Kalai dal* contains a lot of mucilage; it is used as an invalid food in cases of bowel-disorders.

Vegetable Oils.—Among the many kinds of vegetable oils that are used for culinary purposes in India, mustard oil has a monopoly in Bengal. Cocoanut and gingelly oils are largely used in South India for similar purposes. Ground-nut oil and sweet oil are generally used by Europeans resident in India. Mustard oil is extensively adulterated in Bengal. These oils supply heat and energy to the body. All of them are inferior to butter or *ghee* both as regards their digestibility and their vitamin-contents. Many of the vegetable oils contain no vitamin at all. They are cheap but not adequate substitutes for butter or *ghee*. Fresh cocoanut butter is a very good edible vegetable fat.

Vegetables.—Among vegetables, potatoes are considered to be the best. The protein of potato, though small in quantity, is much superior to most other vegetable proteins and, according to Hindhede, potato is capable of serving as an exclusive source of protein for the body. Hindhede reports the case of a youngman who lived on potato and margarine (a kind of fat) for 309 days and did heavy work during this time.

Potato is rich in antiscorbutic and antineuritic vitamins and prevents the incidence of both Scurvy and Beri-beri. It is, however, lacking in lime; this deficiency is made up by taking spinach or other greens and milk along with it. It is rich in soda and potash salts which help to keep the blood in an alkaline condition. The potato starch, as already stated, is the most easily digestible of all starches.

The best method of cooking potato is by baking or steaming. It should not be peeled and soaked in cold water which causes much loss of protein and salts. Where boiled without peeling, the loss of protein and salts is small. If it is to be boiled, it should be boiled with the skin on.

The skin of potato is good roughage and stimulates the movement of bowels.

Onions are very rich in their iron-contents. Young onions are better than mature ones on account of their having a milder flavour. The best method of cooking onions is by roasting them in hot ashes or in a very hot oven. Persons suffering from

anæmia are known to derive benefit by taking a plentiful supply of onions in their diet.

Brinjals and sweet potatoes are very deficient in lime.

Cabbages, spinach and tomatoes contain a very large supply of the different kinds of vitamins. Celery and lettuce are rich in vitamins and contain valuable salts. Lettuce is specially recommended to those who have a tendency to grow fat, with lemon juice only, oil being avoided.

Asparagus abounds in valuable salts and vitamins. It should be steamed instead of being boiled.

Artichoke contains a substance called *inulin* allied to starch and is recommended as a food for diabetics.

Agar-agar is obtained from a species of sea-weed that grows along the coast of Japan and Ceylon. Taken in the crude state, it is an excellent remedy for constipation. It makes much firmer jellies than does gelatine. Being pure cellulose, it cannot undergo putrefaction and so may be used where most animal products are forbidden.

Mushroom does not possess any nourishing properties. It possesses a meat-like flavour. It is an indigestible article of food and some species are poisonous.

Patol, young unripe plantain and *mankachoo* are easily digestible and are largely used in the preparation of invalid dishes.

About the green leafy vegetables (*sak-sabji*), Kellog says :—

"In the green leaf is produced a substance (vitamin A) that imparts to the young the power to grow. Without this soluble vitamin which promotes growth and development, no animal could grow to maturity.

"Greens contain a very considerable amount of cellulose and are thus an excellent sort of roughage. The amount of carbo-hydrates, protein and fat which they present is so small as to be almost negligible. But they are invaluable as the best sort of roughage, a source of *fat-soluble vitamin*, one of the most precious of all vitamins being an activator of growth, and as a means of supplying to the tissues in a convenient and agreeable way the essential requirements of *iron* and of *lime*. Next to legumes (*dal*), the greens show the highest iron-contents per ounce of any class of food-stuffs." Those who look down upon *sak-sabji* as food for cattle, should take a note of this!

Cabbages are placed at the head of the list of green leafy vegetables. It abounds in lime, in both soda and potash salts and contains a considerable quantity of vitamins. These salts and vitamins are largely lost by boiling, hence cabbages should be taken either steamed or raw.

Cauliflower contains a good quantity of salts and vitamins. Green legumes, such as green peas and different kinds of beans, are rich in protein as compared with other vegetables and their iron and

lime contents are also high. Soya bean contains a high percentage of protein and fat and is rich in vitamins also. It is largely used by the Japanese and the Chinese.

The seeds of jack-fruits contain a large amount of protein and they should be more largely used in Bengal.

Fruits.—We shall conclude our brief survey of the common food-stuffs by a short reference to fruits. The general nourishing value of fruits is not high, except in regard to certain nuts which abound in protein and fat. They are more useful for the vegetable acids, salts and vitamin C which they contain in considerable quantity. These keep up the natural alkalinity of blood, prevent the incidence of scurvy and act as mild laxatives by helping the regular movement of the bowels. Lime and lemon juice has long been known to possess high anti-scorbutic properties. A liberal supply of fruits in our daily diet would prevent bacterial growth and fermentation in the intestines, stimulate the action of the liver and relieve costiveness. Fruit-juices are refreshing and nourishing drinks in fever and other diseases and are largely used both as food and drink in such cases.

The protein in almonds possesses a high biological value and the fruit also abounds in fat. Almond, therefore, holds a very important place in a purely vegetarian diet.

The ground-nuts are very rich in protein and fat, their carbo-hydrate contents being small.

Denuded of some of their oil, they would constitute good food for diabetics. They should enter more largely into the diet of the Bengalis to make up its deficiency in protein and fat.

Cocoanut-kernel furnishes a cheap source of protein, fat and vitamins and is largely used in this province as an article of diet.

The vitamin-contents of dry fruits (such as almonds, walnuts, raisins, dates, etc.) is small. Tinned fruits practically contain no vitamins, but canned pineapples and tomatoes have been found to retain their contents of vitamins unaffected.

Oranges head the list of fruits in regard to their vitamin-contents. Children suffering from rickets are greatly improved by taking orange juice. Mangoes, grapes, apples, pineapples, peaches, papayas, plantains, etc., are some of the good fruits highly prized and widely used.

Fruits possess base-forming properties and they, therefore, constitute a very important supplement to human dietary in maintaining the alkaline character of the blood.

CHAPTER VIII

Diet of the Bengalis.

The diet of the Bengalis (including that of the student community) is not only one-sided and, therefore, ill-balanced, but is also wanting in nutritive value. Recent investigations into the dietaries of the people of the different provinces of India by Col. McCarrison, C.I.E., M.D., I.M.S., Director of Nutritional Research, Pasteur Institute, Coonoor, have shown that the food taken by the people of Bengal and Madras compared most unfavourably in its nutritive value with that of the other provinces of India. The Punjab diet of whole-meal *atta* (wheat-flour), *dal*, vegetables and milk, with the addition of meat twice a week, is the best of all Indian diets and no wonder that the Punjabis form one of the finest specimens of the human race in the world. Next, in order, comes the Marhatta diet. The Gurkha diet, according to Col. McCarrison, stands *third* in order of merit. The Bengal and Madras diets, consisting chiefly of rice and nominally of *dal* and other protein-containing elements, are the worst, so far as their nourishing value and vitamin-contents are concerned, and it is not surprising that the people of these two provinces should stand so low in the matter of their physique and physical

qualities as compared with the other vigorous races of India. The Bengal diet is far too rich in carbo-hydrates (starch and sugar) and, sometimes, in fat also (as in the case of the well-to-do people), but markedly deficient in protein (the *muscle-forming* element) and in some of the vitamins.

The result of the continued taking of such a poor and ill-balanced diet for a long time, specially in the growing period of one's life, is retardation in one's growth and development, disinclination for physical exercise and any kind of active work, weakening of the powers of endurance, lowering of vitality, loss of the natural resisting power against infectious diseases, premature old age and, generally, an early grave. If you will look into the present health-conditions of Bengal, you will find that there is far more sickness and mortality prevailing among the people, both adults and children, than it should be. The death-rate in many districts of Bengal exceeds that of the birth-rate which, also, is gradually on the decline. Much of this evil is due to the lowering of the vitality of the people brought on by ill-balanced and ill-nourishing diet. We can remedy this, to some extent, by taking care of the diet of our students, many of whom live under our care and supervision in the various hostels and messes attached to the schools and colleges in Bengal, and, through them, it is my hope that it will be easy to introduce food-reform into the homesteads of Bengal.

The health and physique of the Bengalis were not so poor a few generations ago. Time was when

the people of this province were not unaccustomed to military life and service, for they formed regiments which successfully fought against the disciplined army of the Mughal Emperors of Delhi. In the latter half of the 18th century, the fighting units of the celebrated *Lal Paltan*, under such British commanders as Col. Forde and Capt. Knox (as described by Malleson and Broom), were mostly Bengalis and they showed their prowess, courage, endurance and the other manly qualities of a soldier in successfully counteracting the military operations of the French in the struggle for supremacy in South India. There was then plenty of nourishing food (such as milk and fish) available in the land, and people could afford to take them in the right quantity. It is the dearth of these two staple articles of food in Bengal at the present moment that has made the diet of the generality of the people so poor in its nutritive value and has contributed to the deterioration of the health and the lowering of the resisting power against the onslaught of diseases. It is the duty of every true son of Bengal to devise means and adopt measures for the increased supply of milk and fish throughout the province. This will improve the diet of the people and make the country smile once again in health and prosperity.

It has been stated elsewhere that there is a difference of opinion about the minimum requirement of protein in the daily diet of a healthy youngman. Most European and American physiologists have, after careful investigations, come to the conclusion that a healthy youngman (of those countries)

of average height and weight and engaged in ordinary activities should get 100 grammes (a little over 3 ounces) of protein of good quality in his daily diet. A lesser quantity would re-act upon his health and constitution and prejudicially affect his working capacity and his powers of resistance against diseases. Chittenden, however, and a few others belonging to his school, consider the above quantity to be too high, for, in their opinion, 40 to 50 grammes of protein ought to be quite sufficient to to keep an individual in good health and in full activity. Without entering into the details or the merits of the controversy, we may say at once that Chittenden's view is not endorsed by most physiologists of Europe and America and our Indian experience also does not support it. None of the vigorous races in India or in other parts of the world gets less than three ounces of protein in their daily diet. Those people in India who get less than this quantity, *e.g.*, the Bengalis, the Beharis, the Orias and the Madrassis, fall far behind the other races of India in respect of their physique and physical qualities. The following table compiled from McCay's, "*Protein Element in Nutrition*" shows the average quantity of protein available in the daily diet of different people living in India. This table affords a striking study in comparison on the relation existing between the quantity of protein daily ingested by a people and the standard of health and vigour maintained by them.

TABLE XII.

Races.	Amount of protein available in daily diet (average).
Bhutia	5 to 6 ounces.
Tibetan	Do. "
Dogra and Punjabi Mussalman ...	5 "
Jat	4·5 "
Sikh	4 "
Rajpoot	4 "
Englishmen	4 "
Nepalee	3 "
Japanese	3 "
Biharee	2·5 "
Bengali (East Bengal)	Do. "
Do. (West Bengal) ...	2 "
Orias	Less than 2 ounces.

In this connection, McCay's experiment is worth noting. He investigated the dietary of two groups of students (Anglo-Indians and Bengalis) who were boarders in the same hostel in a Government College, living under exactly the same conditions as regards residence, study, manual work (in work-shops), physical exercise and games, the only difference being in the matter of food. His observations were made during a period of three years and the results are shown in the table given in the next page. The difference in the matter of food (as ascertained by analysis of diet), consisted in the fact that whereas the group of Anglo-Indian students consumed on an average 3·5 ounces of protein daily, the Bengali students did not get more than two ounces of protein per day and that protein was not of the best biological value. The difference in the physical development of the two groups of students during the

period of three years was very striking. The Anglo-Indian students grew in *weight* to a *considerable* extent and both their *height* and *chest* measurement *also increased*. Only two per cent. among the Anglo-Indian students showed reduction in weight during this period. In the case of the Bengali students, the increase in *height* and *weight* was *in no case* to any *appreciable* extent and, further, many among them (about 42·8 per cent.) became *reduced* in weight. It is reasonable to conclude that protein-insufficiency in their daily diet was responsible for retardation in the physical growth of the Bengali students, who, in every other respect, were on an equal footing with their Anglo-Indian fellow-students.

TABLE XIII.

Nationality.	Number of students.	Average increase in weight.	Reduction in weight per cent.	Average increase in chest-girth.	Average increase in height.
Anglo-Indians ...	126	14 lbs.	2	2 inches	Marked.
Bengalis ...	568	2 lbs.	42·8	Negligible	Slight.

It will be noticed at once that all these Bengali students got more protein in their daily diet than what Chittenden and his school consider to be sufficient for a healthy young person to live and grow upon and be in full activity of life, yet they suffered badly in their physical growth and development. In the present case, at least, Chittenden's recom-

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mendation of a low protein diet does not stand the test. Neither does it find support in the figures given in Table XII, which show that the Bengalis, the Beharis and the Orias, who normally live on a low protein-diet (though larger in quantity than what Chittenden would allow) are much weaker physically than the other races living on a more liberal protein-diet.

Recent enquiry into the dietaries of the different hostels attached to various colleges in Calcutta—Government, Missionary and private, shows that there is much room for improvement in the food of our student-community as provided for in these institutions. It has already been stated that the minimum daily requirements of protein and fat in the case of a healthy Indian adult of average height and weight and engaged in ordinary work are 90 and 60 grammes respectively and that his food for 24 hours should yield an energy-value of not less than 2,800 calories. But in none of these hostels, the diet that is given comes up to this minimum standard of efficiency. There is shortage of protein in every one of them (although the shortage in the case of one or two hostels is slight only) and there is always an excess of carbohydrates in the form of rice. In the case of one of the hostels attached to a private college, the drop in protein is very marked (being less than 60 grammes), and there is marked deficiency in fat also. These diets also suffer considerably in their energy-value, the calories in some cases hardly exceed the figure of 2000. Young men in the growing and most active period of their lives,

should get more protein and more energy than that provided for in the minimum standard of dietary, but in the case of our youths, residing in the college hostels, the allowance falls far short even of the minimum requirements. It is no wonder, therefore, that the health of our students, as found by the Students' Welfare Committee of the Calcutta University, should be so much below par, or that they should show so much disinclination to undergo physical exercise or join sports or that nearly two-thirds of them should suffer from one or other kind of bodily ailment, or that they should readily fall victims to infectious diseases. It is high time that this matter should engage the serious attention of the guardians of our boys and the heads of our schools and colleges and no time should be lost in improving the dietary of the student community of Bengal. It may be noted with satisfaction that the Students' Welfare Committee of the Calcutta University has taken up this matter in earnest and is trying to introduce healthy reforms in the dietaries of our college hostels and messes. We heartily wish the Committee success in its laudable endeavours.

The most common defect in the Bengali diet is that it is too rich in starch and sugar and far too poor in protein (the muscle-forming element). Bengalis, old and young, as a rule, take a large quantity of rice which is rich in starch and poor in protein, salts and vitamins. No doubt, rice is an easily digestible article of food, but when taken in large quantity, it tends to distend the stomach and interfere with its normal movement and function.

Stomach is the organ that is principally engaged in the digestion of protein-food, and the presence of a large quantity of starchy food, like rice, interferes with the digestion of protein-food, such as *dal*, fish, meat, and milk, taken along with rice. The result is that the prolonged retention of rice in the stomach causes it to ferment, thereby producing hyperacidity, heart-burn and wind and causing much discomfort, two or three hours after the ingestion of a heavy rice-meal. It leads to permanent dilatation of the stomach, and the organ being thus debilitated, the victim suffers from chronic dyspepsia throughout his life often followed by diabetes. It has often been noticed in the postmortem rooms of our hospitals and police morgues that whereas in the case of Europeans, the stomach presents a normal appearance in size and texture, the organ in the case of rice-eating Indians is generally found to be much enlarged and flabby. The bulkiness of the diet has much to do with this abnormal condition of the stomach among the rice-eating people of Bengal.

If the people of Bengal have a great bias for rice, most of them entertain a prejudice against *dal*, which they generally take in small quantities, lest they suffer from indigestion. Owing to financial considerations, the average Bengali cannot afford to have a regular allowance of sufficient milk in his daily diet and, for the same reason, has to satisfy himself with an insignificant quantity of fish. The result is that the protein-yielding elements in his daily food are insufficient and he tries to balance the diet by consuming a large quantity of rice. No

doubt, he draws a fair amount of protein from rice, but at what a cost? The bulky nature of the food brings on debility and derangement of the digestive organs and makes him a life-long sufferer from dyspepsia, which is the most common disease in Bengal.

Another defect is to be found in the insufficient quantity of some of the important vitamins present in the daily diet of the people of the province. There is shortage of both " A " and " B " vitamins. Vitamin " A " is to be found in milk, butter, *ghee*, beef-fat and green leafy vegetables. The poverty question again comes in here, and accordingly, milk, butter and *ghee* are practically forbidden articles of food. Beef-fat is out of the question for a Hindu Bengali, and green leafy vegetables have come to be regarded by the so-called educated and city people as food fit for cattle only. Fish-oil contains a good quantity of " A " vitamin but the quantity of fish consumed daily by a Bengali of ordinary means is so small that he gets no appreciable amount of the vitamin from it. The liver, kidneys, heart and the brain of animals contain a fair amount of this vitamin, but flesh-food is either a luxury with the majority of this class of people or it is forbidden by caste-rules. The result is that the present-day diet of the Bengalis falls far short of the proper quantity of vitamin " A " in it.

There is also deficiency of vitamin " B " in the diet. Wheat contains more vitamin " B " than rice, but Bengalis, as a rule, prefer rice to wheat and they often take polished rice which contains no

vitamins. The pulses (*dals*) contain a good amount of vitamin "B," but this, too, is not a favourite food with the Bengalis, forming only a small part of their daily diet, in contrast with the habits of their vigorous brethren in the United Provinces and the Punjab. Much vitamin is also lost by the throwing away of the water in which rice is boiled.

The chief source of fat in the present-day diet of the Bengalis is mustard oil, which is practically devoid of all kinds of vitamins. *Ghee* contains a good quantity of this principle, while most vegetable oils contain little or nothing. Very few people can afford to have an adequate supply of *ghee* in their daily diet, and even then, the *ghee* that is ordinarily sold in the bazar is so largely adulterated with lard or vegetable oils that the supply of vitamins from this source is practically unavailable.

The combination of these circumstances, among other causes, has considerably lowered the nutritive value of the present-day diet of the Bengalis, both in respect of its protein and vitamin contents, and this is telling seriously upon the physical and economic well-being of the race.

The next point to consider is—how to remedy these defects? The best asset of an individual as well as of a race is its health and physical fitness, and these should be secured at all costs. It is a difficult problem having regard to the fact that improvement in dietary would necessarily mean increased expenses which the people of this class cannot easily afford. Educating public opinion in the matter of proper dieting will go a great way in effect-

ing the needful reform. People must be made to understand that what they now spend on food is hardly enough to maintain them in health or to give them strength, that a little more expense under this head will benefit them in the long run by increasing their capacity for work and decreasing their susceptibility to attacks of diseases, that they must accustom themselves to balance their income and expenditure by curtailing expenditure on many avoidable social functions and personal vanities and spending the money thus saved on an improved dietary for their children. They must also be made to learn the comparative nutritive values of the various food-stuffs in daily use and how by a little manipulation, in the way of substitution and modification, these could be so combined as to ensure a more improved dietary, without necessarily increasing the cost. I am glad the propaganda work has been taken in hand by the Students' Welfare Committee and by some of the Ward Health Associations and Students' Unions of Calcutta. Lantern lectures are being given under the auspices of the Public Health Department of Calcutta on the defects of the present-day diet of the people with suggestions how to correct and improve them. Centres should be opened in all parts of Bengal to successfully carry out this propaganda work, as is being done in the matter of the prevention of infectious diseases and child-welfare and maternity work. They should also form part of the course in Elementary Hygiene and included in the curriculum of studies both for boys and girls in all schools in

Bengal. The authorities of schools and colleges should watch with a jealous eye both the quality and quantity of food supplied to boarders living in hostels and messes attached to those institutions and try to improve them on the lines suggested by the Students' Welfare Committee. The guardians of the boys and girls should do the same thing to improve the diet of their wards at home. If these suggestions are acted upon, it is hoped that the health and physical condition of the student community of Bengal would, before long, show an appreciable change for the better.

One of the suggestions that I would venture to make in this connection is the substitution of whole-meal flour for rice in one of our two principal daily meals. Wheat contains nearly double the quantity of protein contained in rice and is also much richer in vitamin B, fat and salts. Fine white flour should, as far as possible, be avoided, for it contains little or no vitamin and is much poorer in its protein and salt contents also. As already noted, the latest investigation of Col. McCarrison into the comparative nutritive merits of whole-meal flour and fine white flour establishes, beyond doubt, the superior claim of whole-meal *atta* over fine flour, and this should always be borne in mind in the construction of dietaries for our student population. Bengali students show a decided preference for rice and an aversion for *atta*. This is the result of prolonged habit and should be gradually overcome. A mixed diet of rice and *chapatees*, both for the morning and evening meals, will go a great way towards balanc-

ing the diet, without coming into conflict with the habits of long years. It will improve the quality of the diet and, at the same time, reduce its bulk. It cannot be denied that those races in India, who take *rotee* (made of whole-meal wheat flour) and *dal*, are much stronger and hardier than those who live on rice and *dal*.

The addition of a little more *dal* to the daily diet of the Bengalis will considerably enhance its protein and vitamin-B contents. *Dal* is richer in protein than meat or fish (the average percentage being 24, as compared with 20 and 18 of meat and fish respectively), but the protein of *dal* (legumin) is biologically inferior to that of meat and fish. When supplemented, however, with some animal protein (as that of milk, fish, meat or eggs), the protein of *dal* could be fully utilised in the system, and this important fact should always be borne in mind. Those who live mainly on *dal* and *rotee* or *dal* and *rice*, should take some milk or milk-products (*dahi* or *chhana*) regularly, or some fish, meat or eggs instead, in order to make up the defect of the proteins contained in vegetable foods. Besides, *dal* when properly cooked and prepared is not so indigestible or unassimilable as it is commonly believed to be. Hutchinson, in his book on "*Food and Dietetics*," makes the following important observation on the assimilability of pulses in the human system :—

"If properly prepared, the pulses (various forms of *dal*) are absorbed into the intestine very

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thoroughly. Thus, the proteid of pea or lentil is all taken up, except about 8 or 9 per cent., when 200 grammes (about 7 ounces) are given daily. The proteid of pulses, *if given in a fine division*, is capable of very good absorption, considerably better than gluten (proteid of bread) when taken in the form of white bread."

This is supported by our Indian experience. The manner in which *dal* is cooked in our hostels and messes, and often in our houses, is faulty and needs improvement. *Dal* could be taken in so many different kinds and forms and in such attractive preparations, that there should be no difficulty, on the ground of monotony, for our young men to take a larger quantity of this muscle-building element in their daily diet.

The faulty way in which rice is cooked and eaten by the *bhadralog* classes in Bengal should also be corrected. The rice-water is generally thrown away or given to the cattle. The salts, vitamins and part of the protein in rice are thus lost. It is a regular economic drain on the financial resources of the people which are always below par and it is injurious also from the point of view of health. Rice should be so prepared as to retain the water in the boiled grains; or the surplus rice-water, if any, should be taken in separately or given to the children as is the practice with the people of Chotanagpur where the staple food is rice. The Indian dish called *Khichoori*, made by boiling together rice and *dal*, to which *ghee*, potatoes and sometimes green

peas are added, is a very nourishing and palatable article of food, and should be more frequently used in our Bengali homes. It would go to improve the quality of our diet, both as regards the supply of proteins and vitamins.

It was a universal practice at one time, with the old and the young in every Bengali household, to take, as the first thing in the morning, a handful of wetted and softened grams, either with salt and ginger or with brown sugar (*goor*). That practice has practically been given up and a cup of tea with or without biscuits has taken its place. Needless to say that the change has not been for the better, for the cup of tea does not act as a food but only as a stimulant and the biscuits contain no vitamin. The wetted grams, specially if they are sprouting, are full of vitamins B and C, and contain besides a considerable quantity of proteins. The practice should be revived, and sprouting grams should be our daily food in the morning, preferably with brown sugar, which contains vitamin, whereas white sugar contains none. There is no harm in taking a cup of tea along with it. The re-establishment of this practice will, to some extent, make up the deficiency in protein and vitamin in our present-day Bengali diet.

A larger inclusion of green leafy vegetables in our daily diet is urgently called for. It is from this source that we can secure an adequate supply both of vitamins "A" and "C." Vitamin "A" is essential for growth and for the protection of the

body from infectious diseases. It is contained in butter, fish-oil, milk and *ghee* which are not easily available in adequate quantity to people of ordinary means. Our present-day diet, therefore, is considerably lacking in this respect. The easiest and cheapest way of securing vitamin "A" in good quantity is to take every day a sufficient quantity of green leafy vegetables (*sak-sabji*), which are neither costly nor difficult to obtain. Spinach (*palong sak*), cabbage, *kalmi*, *notay*, *chhola sak*, *hincha*, green young mustard plant (*sarsa sak*), *kumra sak*, *laoo sak*, green onion plant, *moola sak*, etc., are some of the most common green leafy vegetables which grow abundantly in the country. Such English leafy vegetables as lettuce, celery, etc., are not difficult to grow and their cultivation should be encouraged. Some of them may be taken raw as salad (as is the practice with the Europeans), for prolonged cooking destroys much of the vitamin-elements contained in them. Tomato contains plenty of vitamins, and its larger cultivation and consumption should be encouraged. It is one of those vegetables which does not happen to lose its vitamin-content in the cooking process. Onions, radishes, green peas, tomato, cucumber, green kidney beans (*barbati*), cocoanut kernel, etc., if taken in a raw condition, would constitute a source of plentiful supply of different kinds of vitamins and it is not unpleasant to take them *raw*. The *sak* (leafy vegetables) is usually condemned as food fit for cattle; this is an objectionable prejudice which should be got rid of. A rich supply of green vegetables to a carrying or a

suckling mother is most beneficial both to herself and to her child. It has been proved that the cow which does not feed on green grass yields milk which is very poor in vitamin.

In carrying out the reforms suggested above, practically no extra expenses are involved. But these alone will not solve the vexed diet-problem in Bengal. In order fully to make up the deficiency in protein and to improve its quality generally, *there should be a more liberal allowance of protein-foods of animal origin in the present-day diet of the people.* This, no doubt, would require extra expenditure. The best way in which this can be done is by providing more milk, fish, meat or eggs in the daily diet and by cutting down the allowance of rice and sweets, in it. Those who are vegetarians should take at least a pint of milk daily and some fresh curd (*chhana*) to supplement their vegetable food with protein of superior biological value. Those who are used to a meat or fish diet, should increase its quantity, so that at least five ounces form the daily ration, and it would considerably improve the diet if they take a small quantity of milk or *dahi* along with it. Egg is a most nourishing and complete food; it contains a good amount of protein, fat, vitamins and valuable salts. The present-day Bengali diet would be greatly improved by the addition of one or two eggs daily to it. There is an ill-founded prejudice against the use of eggs which should be got over. Duck's eggs are as good as hen's; besides they are cheaper and yield a larger quantity of nourishing materials than hen's.

We take vegetable oils and *ghee* to supply heat and energy to the system. Vegetable oils are generally very poor in vitamins, but both butter and *ghee* are rich in them. An adequate quantity of butter and *ghee* should form part of our daily diet.

Milk, fish, meat, eggs, butter and *ghee* are costly articles of food, and may not, ordinarily, be within the reach of many families in Bengal. But, considering their high food-value and their importance in the growing period of life, one or other of these articles must find place in the diet of our young people and the money needed for that must be found, even though it be by curtailing expenditure in other directions.

THE END.

ALPHABETICAL INDEX

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